THE

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ELECTRICAL RADIATION.

THE startling discovery of Prof. Röntgen has led to a great revival of interest in the whole subject of electrical discharge in high vacua. The credit to be given to the different investigators in this field, and the explanation, especially of the nature of the cathode rays, have for some time formed a black spot between English and German physicists. It is to be feared that the patriotic bias has, somewhat, on both sides prevented the credit being given where it is due. We do not propose to attempt the complete discussion of a question which now possesses a very extensive literature, but would draw the attention of those interested in the subject to Lord Kelvin's presidential address to the Royal Society in 1893, in which the question is discussed principally from the historical side.

The main line of descent of the recent discoveries may be traced from Faraday, through Maxwell and Hertz, to Lenard and Röntgen. Lord Kelvin points out that Hertz's remarkable discoveries about electro-magnetic waves were almost anticipated by Prof. G. F. Fitzgerald in two papers read before the British Association in 1883, but characterises Hertz's electrical papers as "a permanent monument of the splendid consummation now realised."

"But, splendid as this consummation is," Lord Kelvin continues, "we must not fold our hands and think or say there are no more worlds to conquer for electrical science. We do know something now of magnetic waves. We know that they exist in nature, and that they are in perfect accord with Maxwell's beautiful theory. But this theory teaches us nothing of the actual motions of matter constituting a magnetic wave. Some definite motion of matter perpendicular to the lines of alternating magnetic force in the waves, and to the propagation of the action through space, there must be, and it seems almost satisfactory as a hypothesis to suppose that it is chiefly a motion of ether with a comparatively small, but not inconsiderable, loading by fringes of ponderable molecules carried with it. This makes Maxwell's 'electric displacement' simply a to and fro motion of ether across the line of propagation, that is to say, precisely the vibrations in the undulatory theory of light according to Fresnel. But we have, as yet, absolutely no guidance towards any understanding or imagining of the relation between this simple and definite alternating motion, or any other motion or displacement of the ether, and the earliest known phenomena of electricity and magnetism—the electrification of matter, and the attractions and repulsions of electrified bodies; the permanent magnetism of loadstone and steel, and the attractions and repulsions due to it; and certainly we are quite as far from the clue to explaining, by ether or otherwise, the enormously greater forces of attraction and repulsion, now so well known after the modern discovery of electro-magnetism.

"Fifty years ago, it became strongly impressed on my mind that the difference of quality between vitreous and resinous electricity, conventionally called positive and negative, essentially ignored as it is in the mathematical theories of electricity and magnetism, with which I was then much occupied (and in the whole science of magnetic waves as we have it now), must be studied, if we are to learn anything of the nature of electricity and its place among the properties of matter. This distinction, essential and fundamental as it is in frictional electricity, electro-chemistry, thermo-electricity, pyro-electricity of crystals, and piezo-electricity of crystals, had been long observed in the old known beautiful appearances of electric glow and brushes and sparks from points and corners on the conductors of ordinary electrical machines, and in exhausted receivers of air pumps with electricity passing through them. It was also known, as many as 50 years ago, in the vast difference of behaviour of the positive and negative electrodes of the electric arc lamp. Faraday gave great attention to it, in experiments and observations regarding electric sparks, glows, and particularly in his 'dark discharge' and 'dark space' in the neighbourhood of the negative electrode in partial vacuum. In [1523] of his 12th series, he says: 'The results connected with the different conditions of positive and negative discharge will have a far greater influence on the philosophy of electrical science than we at present imagine.' His 'dark discharge' [1544—1554] through space around or in front of the negative electrode, was a first instalment of modern knowledge in that splendid field of experimental research, which, 15 years later, and up to the present time, has been so fruitfully cultivated by many of the ablest scientific experimenters of all countries.

"The Royal Society's *Transactions* and *Proceedings* of the last 40 years contain, in the communications of Gassiot (1860), Plücker (1860), Andrews and Tait (1860), Robinson (1862), Cromwell Varley (1871), De la Rue and Muller (1875—1883), Spottiswoode and Moulton (1875—1880), Grove (1878), Crookes (1879—1881), Schuster (1884—1890), J. J. Thomson (1887—1891), Fleming (1890), almost a complete history of the new province of electrical science, which has grown up largely in virtue of the great modern improvements in practical methods for exhausting air from glass vessels, culminating in Sprengel's mercury shower pump, by which we now have vacuum tubes and bulbs containing less than $\frac{1}{1000000}$th of the air which would be left in them, by all that could be done in the way of exhausting (supposed to be down to 1 mm. of mercury) by the best air pump of 50 years ago. A large part of the fresh discoveries in this province has been made by the authors of these communications, and their references to the discoveries of other workers very nearly complete the history of all that has been done in the way of investigating the transmission of electricity through highly rarefied air and gases since the time of Faraday.

"Varley's short paper of 1871, which, strange to say, has lain almost, or quite, unperceived in the *Proceedings* during the 22 years since its publication, contains an important first instalment of new discovery in a new field—the molecular torrent from the 'negative pole,' the control of its course by a magnet, its pressure against either end of a pivoted vane of mica, according as it is directed by a magnet to one end or the other, and the shadow produced by its interception by a mica screen."

These experiments of Cromwell Varley, referred to by Lord Kelvin, certainly deserve more attention than they appear to have received. Varley employed a battery of 323 Daniell cells to send a current through a Geissler tube. When the current was gradually increased, he found that the glow light first appeared on the positive pole; and before it was visible to the eye, it could be photographed by an exposure of 20 minutes. When the current was still further increased, the light about the anode became more brilliant—a tongue of light projected from the anode to the cathode, the latter being still almost completely obscure. The light about the anode was white, while the projecting flame was brick red and possessed great photographic power. With increasing current the flame became detached from the anode. The cathode began to glow, then the anode almost ceased to be luminous, and finally a blue glow spread over both sides of the cathode. This blue glow on the cathode was found to have very little photographic power; the red flame beyond, however, had very strong photographic power, the photograph showing a white flattened hour glass apparently detached from the cathode ring. Varley found the current increased by abrupt steps as the E.M.F. was gradually increased, the first change taking place when the red flame was produced, and the second when the blue glow appeared on the cathode.

Varley also found, as stated by Lord Kelvin, that the cathode discharge exerted a pressure on a vane of mica, was deflected by a magnet, and formed shadows of interposed bodies. But Plücker, in 1860, discovered the existence of electrical shadows, and Hittorf, in 1869, completely investigated the action of the magnet on the cathode discharge.

If we are to judge from the omission of Hittorf's name in Lord Kelvin's address, he does not consider that he takes an important place as a discoverer in this field. But no one can read his memoir "On the Conduction of Electricity in Gases," published in Poggendorff's *Annalen* in 1869, and fail to see how much of what we know about the cathode discharge is due to him. Hittorf does not appear to have discovered in the cathode radiation the stream of electrified particles, whose existence was afterwards established by Crookes and other experimenters — among them quite recently Perrin* has collected the negative charge from the cathode stream shot into a Faraday can surrounding the anode. But Hittorf showed that the cathode radiation started at right angles to the surface of the cathode, and moved in straight lines independently of the position of the anode, that it was deflected by a magnet, and that it was obstructed in its formation by the too great proximity of the sides of the containing vessel or the anode.

"Quite independently of Varley," continues Lord Kelvin, "and not knowing what he had done, Crookes was led to the same discovery, not by accident, and not merely by experimental skill and acuteness of observation. He was led to it by carefully designed investigation, starting with an examination of the cause of irregularities which had troubled him in the weighing of Thallium; and going on to trials for improving Cavendish's gravitational measurement, in the

* *Comptes Rendus*, December 30th, 1895, pp. 1131—1133.

course of which he discovered that the seeming attraction by heat is only found in air greater than $\frac{1}{1000}$th of ordinary density; and there is repulsion increasing to a maximum when the density is decreased from $\frac{1}{1000}$th to $\frac{8.6}{1000000}$th, and thence diminished towards zero as the rarefaction is farther extended to density $\frac{1}{2000000}$th. From this discovery Crookes came to his radiometer first without, and then with electrification; and powerfully aided by Sir George Stokes, he brought all his work more and more into touch with the kinetic theory of gases; so much so, that when he discovered the molecular current, he immediately gave it its true explanation—molecules of residual air or gas, or vapour—projected at great velocities by electric propulsion from the negative electrode. This explanation has been repeatedly and strenuously attacked by many other investigators, but Crookes has defended it, and thoroughly established it by what, I believe, is irrefragable evidence of experiment. Skilful investigation, perseveringly continued, brought out more and more of wonderful and valuable results; the non-importance of the position of the positive electrode, the projection of the torrent perpendicularly from the surface of the negative electrode; its convergence to a focus, and divergence thence forward when the surface is slightly concave; the slight, but perceptible, repulsion between two parallel currents, due, according to Crookes, to the negative electrification of their constituent molecules; the change of direction of the molecular torrent by a neighbouring magnet. . . . In the whole train of Crookes's investigations on the radiometer, the viscosity of gases at high exhaustions, and the electrical phenomena of high vacuums, ether seems to have nothing to do except the humble function of showing to our eyes something of what the atoms and molecules are doing. The same confession of ignorance must be made with reference to J. J. Thomson's and Schuster's researches. . . . It seems certainly true that without the molecules of residual gas there could be no current, and that without the molecules electricity has no meaning. . . . Ether is certainly also an essential, and certainly has more to do than merely to telegraph to our eyes to tell us what the molecules are about."

The last passage would seem to imply that Lord Kelvin considers that there may be something more in the cathode radiation than a torrent of negatively-electrified particles; that, in fact, the ether itself may take its share of the energy radiated. After all, an agreement between English and Continental physicists on this fundamental question may not be so far off.

Luminescent Lamps.

Ebert's luminescent lamp does not appear to have realised the great expectations that were formed of it when it was first brought out. Whether the inventor has not had time to develop his invention, and whether it has turned out to be impracticable, we do not know, but the useful electric light for a millionth of a watt still remains a dream of the future. Meantime, other experimenters have been working at the problem of obtaining light without heat, and notably Mr. Moore in the United States has achieved considerable success. Mr. Moore obtains his light from vacuum tubes of the ordinary kind, but of considerable length. No electrodes are fused into the tubes, so that the discharge in the tubes must be due to impulsive currents. The photograph which we reproduce in this number, shows that there is a good prospect of producing a serviceable light by these simple means, and we wish Mr. Moore further success in his interesting experiments.

Researches on Aluminium.

A useful contribution to our knowledge of aluminium has recently been made by Henri Moissan, and is given at length in the *Proceedings* of the Paris Academy of Science (*vide Comptes Rendus*). He refers to the disappointing and often contradictory results to which experimentalists who have occupied themselves with the properties of this metal have arrived. In illustration of this he points out, that whereas in some cases aluminium has behaved exceedingly well when made into vessels, such as drinking cups—on the other hand it has behaved extremely badly. It seems that these difficulties depend on the difference of composition of industrial aluminium. Contrary to the general notion, aluminium may contain nitrogen and carbon, and when it does its properties are remarkably modified. For example, its breaking and extension weight decrease rapidly. Moissan has now recognised an impurity which seems to have a great importance as regards the preservation of the metal, having discovered that when the metal is prepared by electrolysis it invariably contains sodium. In the paper to which we have alluded, he describes a number of experiments, chiefly of a chemical nature, by means of which the existence of sodium in aluminium can be demonstrated. He is of opinion that the presence of sodium in industrial aluminium shows that the electrolysis of the mixture of cryolite and alumina gives rise to a number of secondary reactions in which the sodium may play a different part according to the composition of the bath and the intensity of the electric current. Alloys which may be prepared from aluminium will possess quite different properties, according as they do or do not contain a small quantity of sodium. According to Meissonier, samples of aluminium frequently contain as much as 4 per cent. of sodium. It is not to be wondered at that an alloy which is not homogeneous should be very difficult of preservation. (Dumas in his memoir on the equivalent of aluminium insisted on the non-homogeneity of aluminium prepared by the procedure of Deville). Moissan describes the bad effects which are due to the want of homogeneity, and explains the disintegration to the formation of small battery elements over the surface of the metal. He states, on the other hand, that when the metal is quite homogeneous containing neither nitrogen, carbon, nor sodium, there is no point for attack, and consequently the metal does not waste. *Inter alia* he remarks that aluminium having a great disposition to form couples with every other metal should never be used except alone. A mere particle of iron or brass in contact with aluminium will always in a short time effect the oxidation of the metal and its conversion into alumina. All industrialists who have had to operate upon large surfaces of aluminium have probably observed at their own expense the generality of this decomposition.

The Fatality at Cheltenham.

The opinion and recommendations which are made by Major Cardew on the recent fatal accident at Cheltenham, and published on another page, are very important. They are all the more important because the accident occurred in a transformer chamber which was exceedingly well designed. If, under these circumstances, great and special precautions are necessary, how much more imperative are they in the transformer chambers that exist in many systems.

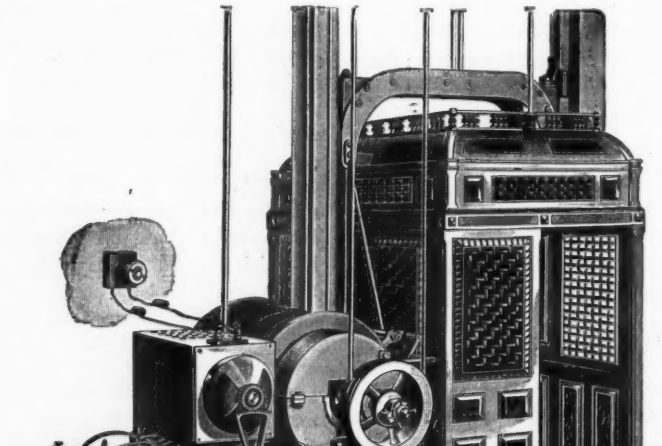
ELECTRIC ELEVATORS.

By Wm. A. GIBSON.

So many letters are reaching us from electrical engineers throughout the kingdom, and also from the Continent, that we are constrained to believe that some general information in regard to the Otis electric elevator will be found of interest to your readers.

It need hardly be said that there is no difficulty in arranging an electric motor in combination with other machinery, to make a lift ascend and descend, and to lift a required load. This was obvious from the beginning, but it was equally obvious to us that much more than this was necessary to produce in an electric elevator all the qualities that are required.

Our friends in New York, Messrs. Otis Brothers & Co., have made this a matter of study for more than 15 years past. From the very first, they were able to combine an electric motor with other apparatus for a lift, but it took years before they were able to produce the desired result. When this had been done, we still preferred to wait until time should have been allowed to test its merits, and to develop weaknesses or points of difficulty, if such should be found to exist. When two years of experience had been obtained, we considered that the way was clear for us to take it up without hesitation. Our experience now extends over three years, so that there is an accumulation of five years of experience, and there are now more than 4,000 electric elevators of "Otis" manufacture in use. This length of experience, and this number of successful cases, we venture to think may be taken as disposing of any doubts which might arise.



These facts, however, are not widely known, and we still meet cases of persons who have no knowledge, and who have beyond that, a strong prejudice against electric elevators. It is because there are so many of this class that we have thought that some information published in your journal might be of public use.

An elevator, and more especially a passenger elevator, worked electrically, must have certain qualities. There must be a gradual start and stop. There must be a minimum consumption of current. There must be no interference with light, and there must be, besides these qualities, ease of manipulation, low cost of power, maintenance and repair, and last, but above all, safety from any and every conceivable danger.

We may explain that the motor we use is of the ironclad type, the field-magnets being designed to completely enclose the coils, which are either compounded or simply shunt, according to the nature of the work the motor has to perform.

The armature is of the drum type, and wound for a much higher voltage than it is intended to use from the mains. The motor is so designed that once the position of the brushes is fixed there is absolutely no necessity to alter them, the fixed position being the same in whichever direction the motor may be running.

One type of motor has mechanical contrivances to reverse the direction of the current in the armature circuit. This class is operated in the usual manner, by means of a hand rope or hand wheel, by the attendant in the car.

The second type has the reversing done in the fields. This machine is shunt wound, and the field controlling device is manipulated by means of a small handle on a dial, a suitable rheostat being placed in its circuit. We have also a push button device which can be applied to our first-named motor. This first-named motor has a resistance box placed on the top of the motor, and consists of carefully designed gear, to be operated simultaneously with the pulling of the rope in the car. On the attendant doing this, or turning the wheel, as the case may be, the following occur at once :—

1. The brake is released.
2. The reversing commutator is turned to its proper position.
3. The snapper switch closes the field and armature circuits.
4. A solenoid becomes energised, the core of which is attached to a pair of brushes, and, if the car is not overloaded, allows, by a peculiar balancing device, these brushes to rise on a rheostat built up in sections like a commutator, the segments of which are connected to a set of suitable resistances. These resistances are gradually cut out as the motor starts, and they are carefully designed so that the starting current, which is naturally about 20 to 30 per cent. higher than the running current, does not affect the light in the building or neighbourhood. The starting current is instantaneous in duration, and is only perceptible by watching the swinging of the needle in the ammeter.

When the motor has acquired the necessary torque, the series fields are cut out entirely, and only the shunt ones are energised. The resistance box takes little space. There is no heating of the coils, and the sparking at the commutator is *nil*.

The whole of the gear is brought to rest in the usual manner, by the attendant pulling on the hand rope, and instantly on opening the circuit the brake is applied. If the attendant should fail to pull the hand rope, or turn the wheel, then there are stops on the hand rope top and bottom against which the car will strike at the end of its regular travel, and by so doing will pull the rope and do what the attendant has neglected to do. If the hand rope should break there are other stops on the machinery itself which would come into operation when the car reached the end of the journey.

All the safety appliances which are used, act not only on the car or machinery, as the case may be, but on the circuit also, and by opening this the motor is arrested, and cannot by any possible combination of accidents receive current when anything is wrong with any part of the system.

The second type of motor is in principle identical with that which has already been described, but starting and stopping of the car in this case is done electrically, instead of mechanically. Proper signalling apparatus—usually lamps—are fixed in the car to warn the attendant when the circuit is open.

With all these is combined what is really the regular and long used Otis winding apparatus, substantially the same as has been used for the Otis steam elevator for many years past, and with this combination there is used a variety of safety devices which make it impossible for the car to overrun. If the car be started in either direction, and the attendant should fail to operate the stopping device, the machine would automatically cut off the current, apply the brake, and stop everything when the car reaches the end of its travel in either direction. There is also the "slack cable device," which is so designed that if the descending car

should meet with any obstacle which should obstruct its motion, or (2), if the main ropes should slacken or break, would immediately cut off the current, and stop all the machinery.

Still further, all the regular car safeties, including the Otis governor, just as they are used with the hydraulic elevator, are employed, and the entire combination is such that, so far as can be seen, every conceivable danger is guarded against.

We cannot too strongly set forth the facts above given, which go to show that it is *not an experiment*, nor simply a combination of a motor and winding machinery. It is a combination of a *particular motor*, with particular switching and other gear, the only one which satisfactorily meets the requirements of the case, and which is covered by a patent, and belongs to this company exclusively.

It now becomes important to take up the question of the cost of working the lift by electric energy. This is a matter which obviously concerns the interests of all electrical supply corporations, for if electric elevators are successful and come into large use, they are at once provided with a day-load, and furthermore, if it be known that the companies will supply the current at a fair price, and if it be demonstrated that at such a fair price the cost of working these lifts compares very favourably with every other power, then the future of the electric elevator may be said to be assured. Our experience thus far shows that the cost of working an electric elevator is very low, for, unlike a hydraulic elevator, which requires a certain cubic quantity of water for every motion, the electric elevator uses power in proportion to the load actually lifted.

One of the first machines supplied by this company in England was for the Westminster Electric Supply Corporation, in a building of high-class flats belonging to that company. The results of a day's tests made by the company showed the following facts:—

The total travel or rise of the lift was 60 feet. The average distance travelled each time the elevator left the ground floor was 40 feet. The contract load was 1,000 lbs. The average load conveyed was 200 lbs. The number of journeys made during the day was 139.

The cost of a day's work, taking the Board of Trade unit at 5d., was 11·8d. The cost of an average journey was 0·08 of a penny.

Besides the special instance above quoted, there are now a great number of others, and they entirely confirm the experience of the Westminster Company.

It may be claimed, therefore, that it is proved that an electric elevator may be made to combine in itself all the qualities which are desirable in an elevator or lift; that the cost of working is reduced to a point far below any other power, and that there exists no ground upon which to base any doubt or question as to its applicability in any and every case where current can be had.

A 1,500 KILOWATT GENERATOR BURNOUT.

A Chicago exchange quotes the following graphic description of a recent burnout on one of the big direct-connected generators in the power house of the Union Depôt Railroad company of that city.

Through the grounding or crossing of wires a short-circuit was formed on wires leading from the monster dynamo in operation, and in a twinkling it burst into dazzling blue flames that shot out a distance of 15 or 20 feet on either side of the machine and to the height of the ceiling above, while the huge fly-wheel, 25 feet in diameter, became a veritable fire wheel as it whizzed around through the flames at the rate of 75 revolutions to the minute. So brilliant was the spectacle, and so sudden and unexpected, that the attendants were for a moment dazed and blinded.

Assistant Engineer Hoffman and Electrician Pabish were fortunately standing far enough away to be out of harm, and as soon as they could recover from their surprise and realised what was the matter, they made a rush for the engine to shut off the power. This was a dangerous task, as they found, for the lever was within the circuit of the revolving electrical flames. But no time was to be lost; the floor and woodwork around the machine were now on fire, while the dynamo, under the intense heat, was sizzling, crackling and popping to pieces, emitting volumes of smoke from the burning rubber insulation of the wires.

At imminent risk of life Engineer Hoffman dashed into the flames and seizing the lever whirled it around to a shut-off position. By this time the room was so full of pungent rubber smoke as to be nearly suffocating, but this did not deter Engineer Hoffman and his assistants from fighting against the progress of the flames. A water hose was brought into action, and in a few moments the fire was under control. Citizens opposite, who saw the brilliant illumination, equal to 1,000 arc lamps, thought the whole interior of the building, from floor to ceiling, was a roaring mass of flames, and that the employés were perishing in the conflagration.

Great excitement prevailed, and an alarm of fire was turned in, but before the engine reached the scene the danger was over. The accident, of course, suspended all traffic on the road, but only for some 40 minutes, as a number of small dynamos were immediately harnessed on to the circuit and set going to supply the necessary power current.

The disabled dynamo is what is known as a 1,500 kilowatt generator of 2,000 horse power. It is one of the largest dynamos made, and the only one of the kind in the West, outside of Chicago. The machine and its twin engines cost $100,000, and it is estimated that it will cost $10,000 to repair the damage resulting from the accident.

AMERICAN NOTES IN AN ENGLISH WORKSHOP.

A writer in New York *Machinery* (Mr. John E. Sweet), who has recently paid a visit to several English and Scotch machine shops, reproves the mechanics of his own country for knowing so little about what is done in other countries in the mechanical line, and he attributes this to two causes, *i.e.*, "We (the States) think we are leaders in all things mechanical, and hence it is not worth while to know what others are doing, and they also think we are the leaders, and that it is worth their while to know all about it." After recording notes of interest in his visits to various works over here, he turns to the establishment of Messrs. Willans & Robinson, at Thames Ditton. His remarks are worth reproducing:—

At the engine works of Willans & Robinson, Thames Ditton, two wonders await every American, except those who will not admit that anything can be done except what we do. There are a number of features about the engine that students in engineering have been taught to believe are contrary to the best practice; but experience shows that they produce the results, and the style of the engine renders good work necessary, and the good work produces results where it would be wasted on other designs.

The cylinders and steam chests are piled up one above another, and it is important that they be true and in line. These cylinders are bored, reamed and faced on an ordinary lathe, a regular English lathe, with no fixtures except a holder attached to the slide rest to carry the reamer, that is, the reamer is held and driven through the work by the slide rest and not by the tail stock. Mr. Eaton Shore (the works manager who, as well as every one connected with the company, gave me every attention, all information and every opportunity possible to see and learn), is firmly of the opinion, as I am now convinced, that the results obtained could not be continuously produced by the tail stock feed. As an example, a half-dozen cylinders, some 14 inches in diameter and a foot or so deep, with a flange outside at one end and inside at the other, were by the lathe just finished. One taken at random was sent to the testing floor and placed on an oiled surface plate. The testing plug, made like a web pulley with about 2½ inches face, was started in the cylinder and crowded down until about even at the top, when with a finger on the top at one side, the plug was shown to be so free from contact with the sides of the cylinder as to spin around like a top. The man then stood upon the plug, and it carried his weight on the air. This job probably could be done in any good shop if one went at it the right way, but for one thing the castings are made of re-cast pigs, re-cast after the mixtures are made. This makes a uniform iron which is more likely to keep its shape, but is very hard, and that makes the work difficult; such hard cylinders and the accuracy contributes to the success of the engine, but such accuracy would be of no particular advantage in an ordinary engine when the cylinders are distorted by steam in one place or on one side, and exhaust in another.

The Willans engine is in its design, workmanship, and method of construction so dependent one upon the other, that it is not easy to

describe how things are done, and give them their due force, without describing the engine itself, and the whole would be more than a single article would cover, and I find that I must leave it. They have in use what I understand is a common thing, a flexible copper steam pipe, capable of resisting any required pressure, that bends around like a rubber hose. Not a double wire arrangement like Almond's, depending on mechanical fits, but an absolutely tight copper pipe, constructed in such shape as to be easily bent around; an ideal device for an erecting floor.

It is useless to attempt a description of the interesting and wonderful things to be seen at the works of the Willans and Robinson Company, and to one who appreciates wonders, some such thought as this must come to him—the death of a great engineer is a loss to the world. When Peter William Willans died, the world lost a genius.

STATIC CHARGES ON TESTING INSTRUMENTS.

By JAC. STOTTNER, M.I.E.E.

Sometime ago one of the well-known Dolivo ammeters was put into my hands, the owner complaining that sparks passed almost continuously between the pointer and the scale.

After careful examination I came to the conclusion that only a static charge like that of a Leyden jar could be the cause, and my assumption proved to be correct.

Repeated attempts to insulate the instrument, or part of it, failed to prevent that charge and the evident attraction between pointer and scale. The base plate could not be earthed—the E.M.F. being 2,500 volts alternating current—without risk of leakage, and sooner or later of short circuit in the mains. I tried a vacuum (Geissler) tube as a silent discharger, and the experiment proved a perfect success.

The base plate is of zinc, and upon it the solenoid with the indicating device is mounted. This solenoid is insulated from the base plate, while the scale is in direct metallic contact with it. If a 2-inch Geissler tube is connected up between the base plate and the insulated solenoid, static charges are easily neutralised without interfering with the insulation of the instrument in any way. This same static charge is, of course, in no way peculiar to Dolivo instruments, but precisely the same thing may occur to any instrument under the same conditions.

I observed a very similar phenomenon some years ago with a Siemens torsion galvanometer between the torsion button and the outer ring which holds the glass scale. The charge of these two parts affected the damping device so much that the aluminium wing was attracted by the screens, and hence correct reading became impossible until I connected the torsion button to the outer ring by a piece of tinfoil, after which the indicated readings were absolutely correct.

CORRESPONDENCE.

Present Status of the Air-Brake.

Your article on "The Present Status of the Air-Brake," page 787 of your December 27th issue, has been read with interest. Pressure of business prevented writer from referring thereto before now.

While sensible of the honour you did our general manager in quoting so freely from his Montreal address, we are sure you will not consider it amiss if we should make some comments on your article, especially its closing sentence, which says:—"One would not wisely endeavour to apply an electric brake to a steam locomotive, nor does it seem any more desirable to get up air pressure on an electric car for brake purposes."

We cannot assent to the argument. We do not think the analogy is sound. If anything has been settled about the latest practice in the United States, it is the fact that the successful electric brake *is yet to be born*. Further, those electric brakes which were so freely brought to the public notice have been obliged to retire from the field. Even the remaining electric brake now being advertised is not what it should be. It will take considerable cash, labour, and time before it becomes commercial. In view of this, you are quite justified in saying, "One would not wisely endeavour to apply an electric brake to a steam locomotive."

With the air-brake, however, the conditions are vastly different! We do not use steam to generate pressure, but in most of our installations depend (either directly or indirectly) upon the car axle for furnishing compressed air. By means of patented improvements the pressure cuts in and out automatically, and the amount of power consumed is very small. When the compressor is "cut out," there is positively no power consumed.

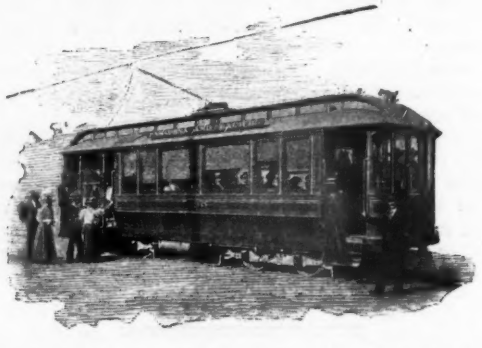
In the first paper the writer had the honour to present before the American Street Railway Association, at Atalanta, he pointed out reasons why air-brakes are destined to supersede all other forms of brakes, and why the former are more reliable than electric brakes.

To reproduce that article would consume too much of your space, but as the address has been extensively reproduced here and abroad, your readers will have no difficulty in referring to it for points.

For braking cars operated at extraordinary speeds we furnish our electric compressor type. For running our slow speed series-wound compressor motor, we tap the motor wiring of car. For our most exacting requirements, even when compressor motor is running at its highest capacity, we consume scarcely as much current as is required for two ordinary lamp circuits. It is only in very exceptional cases that the motor will run at its highest capacity for more than a few minutes at a time.

It has been demonstrated here that motormen cannot rely upon the electric brake, as certainly as upon the air-brake. Without going into any elaborate argument, it is obvious that special reservoirs, filled with compressed air, available for 100 or more stops, will *always* prove a greater source of safety than other forms of apparatus, far more liable to get out of order, and which depend upon the supply of current.

You state: "The general impression conveyed by the paper and discussion is that, so far, air-brakes have not been found altogether successful in American tramway work, but that their need is greatly felt." In his paper the writer certainly understated the merits of air-brakes, rather than risk overstating them. The paper did not advance the idea that



perfection had been reached in air-brakes. It demonstrated, however, that street railway air-brakes are *perfectly commercial*.

The Westinghouse air-brake (which made its bow to the public 27 years ago) is not absolutely perfect; but, as the writer showed in Montreal, it has saved thousands of lives and millions of property since its birth. Moreover, street railway air-brakes have proved altogether successful. You seem to have misunderstood the article in judging otherwise. You state: "To-day there is not an air-brake in St. Louis, although in that city they had a splendid start, &c."

We can best answer that by submitting an advertisement we inserted in the *Street Railway Journal*, December, 1895, under heading "A Point About Discussions." We quote therefrom as follows:—

"That was a most interesting discussion which followed Mr. Wessels's paper on 'The Present Status of the Air-brake,' read before the Montreal Convention. He distinctly announced that his paper was not written for advertising effect. Nor would he violate professional etiquette by mentioning any names."

One St. Louis manager stated several objections had been made to air-brakes on a road in his city.

He should have made clear, but failed to do so, the fact that those air-brakes *were not ours*, nor have we ever had any connection with them, near or remote. The comical part is, that the air-brakes the gentleman referred to were never used on *his* road. He spoke only from "hearsay." No Court of law receives such testimony as evidence. Neither should you, at least without ascertaining the *facts* in the case.

The truth is, those obsolete air-brakes were in Mr. Wessels's mind when he read from his paper:

"*There were air-brakes which entered the lists at the last Convention which have retired from the field; some are still bearing the heat and burden of the day. It is a case of the survival of the fittest.*"

Our air-brakes are "bearing the heat and burden."

In replying to the gentleman, Mr. Wessels showed that the St. Louis and Suburban Road was the one on which the air-brakes referred to were operated, and that they felt the need of air-brakes *so badly* that they themselves *rebuilt* those which broke down.

And since then *that* air-brake system has become obsolete. Those brakes were manufactured in the West. Ours are manufactured in the East, *and remain*. We are still doing business at the old stand.

By the way, wouldn't it have been far more interesting for the Convention to have heard directly from *some one connected with the road* to which the gentleman referred, instead of listening to an outsider, who could not speak officially about what he didn't know except at "second-hand." We think so.

If you'd like to know about our system, send for addresses on "Power-Brakes *versus* Hand-Brakes," and "The Present Status of the Air-Brake."

This speaks for itself. Surely no further comment on discussions is needed.

As illustrative of the *perfectly successful operation* of our air-brakes, we call your attention to the article in the *Street Railway Journal* for February, 1896, in which you will observe a number of cuts of cars being successfully braked by the "Standard." We also send you under separate cover an electro of a heavy car used on the Pacific slope, which you will perhaps be kind enough to reproduce with this letter.

We are now filling the third order from that road. Had our air-brakes not been successful the buyers would not, after a year's trial, have sent us the third order to equip 28 additional cars.

But perhaps the best evidence of the success of our air-brakes is the fact that hundreds of them are in satisfactory operation around the globe. Modesty kept writer from mentioning that fact on the Convention floor.

The Standard Air-Brake Company.
E. J. Wessels, *General Manager.*

New York, *January 25th*, 1896.

Cable Defence Scheme.

As you have so decidedly "trodden on the tail of my coat," in your issue of last week, I shall be glad of leave to defend, and as your editorial sanctum is not a "coward's castle," I feel sure you will grant my request.

As to the cable itself, it must be obvious to you that it is a very condensed specification, but here it is more in full:—"A conductor of seven tinned copper wires, each No. 22 L.S.G., stranded, insulated with pure and vulcanised India-rubber, sheathed with steel wires, made up in strands of three wires, each No. 20 L.S.G. The price of this cable would be £60 per knot delivered in tank at our works. The total overall diameter would be 0·45 in., and the weight 11·4 cwt. dry in air, or 8·75 cwt. when immersed in salt water, the above weights being per knot."

I cannot imagine it is in regard to the want of full details in this specification that you "kick" as much as against its lightness generally; and here let me state that if the cable was to be paid out through the usual drum and brake, or dragged out, the risk of injury would be very much too great, but as it is to be thrown overboard, as it were, the maximum strain would come, not when running at high speed but when crawling along or "lying to," the cable being then practically perpendicular in the water, and having as its maximum strain its own weight in 100 fathoms of water plus whatever might be due to current, &c. Surely it would be equal to this.

Now, as to space occupied, I frankly own I am wrong. I designed the size of tank for a much heavier cable before I received the specification referred to above, and had, until your article appeared, quite forgotton there was a discrepancy in diameter. If, however, this small size of cable *can* be used we get a very compact drum.

With reference to the question of slack, in my earliest conception of this plan, I provided for a small motor to the final guide wheel to throw overboard the slack, but reasoning from the fact that if the vessel was moving two knots and the drum rotating to pay out 2½ knots, it is practically certain the cable would by its own weight be drawn overboard, I could not definitely say the supplementary assistance referred to would be wanted.

As speed is increased, possibly a change takes place in these conditions; it is difficult, however, to imagine the cable piling up at some intermediate point and only falling overboard the rate the vessel was travelling. Even were it so, however, we should then only be reduced to a condition which is quite in accord with your own views when you say, "But we are not at all sure that, for the purpose in question, any slack would be necessary." A motor of very small power on the final wheel would, in any case, meet the point and literally throw overboard slack to any extent, limited, indeed, only by the difference between the vessels maximum speed and the maximum speed at which the drum could be rotated, and only such tension being thereby put on the cable as the easily regulated power of the driven stern drum might be made to cause. We are, therefore, justified in using a very light cable.

Other considerations, however, enter into the question which are important for the special purpose. Being intended for war purposes, and in connection with them, of the most vital importance, *no risks* would be allowable; indeed, it would be unpardonable for me to suggest, as you do, "that it is very possible that the cable would pay itself out better without any mechanism whatever;" of course, it is possible, but would you suggest it would be safe to *rely* upon it, that it would *always* do so?

I maintain that however much subsequent experience might justify the simplification of the mechanism used, all the means I have set forth do conduce to effective work without running risks more than obtain in the ordinary use of machinery, such as, for instance, in the main engines of the cruiser. But other points have also to be considered in war time; for instance, such a cruiser might have to replenish her stock at sea; it would be easy to send out a vessel equipped with similar drums, and reel off to our cruiser a new supply which would be wound on her drum infinitely more quickly than any ordinary way of coiling in tanks. This fact alone would make usual methods out of the question, leaving out that the vessel has a duty to perform which at one time needs all her speed, and another requires simply to "lie to," therefore making perfect control of the cable delivery essential.

You may say this would need a lot of attention to the controlling mechanism, but what of that when this is the primary purpose for which the vessel is built and equipped.

I have too much trespassed on your space, therefore I will, with your permission, leave the "log" question to another issue, and, as probably few of your readers have seen the plans I proposed to use, I would be glad if you would allow me to illustrate my defence with sketches.

C. Scott Snell.

London, *February 18th*, 1896.

[We shall be pleased to see Mr. Snell's sketches, but cannot promise their publication.—Eds. Elec. Rev.]

Megohms per Lamp.

It is wonderful how readily most people adopt without consideration any convenient phrase that they hear other people use. The above choice specimen is a case in point. Who is the true and first inventor thereof, I do not know; probably somebody experimenting, like the late Lord Beaconsfield is reported to have done in his novels, on what the British Public would swallow. The reduction on taking a quantity at, say, 12½ megohms per lamp leaves ordinary wholesale discounts "nowhere." If there were any difficulty about finding a convenient and reasonable expression without creating a new meaning for that much used, and now much abused, word *per*, one could understand the formal creation of the new meaning; but where is the difficulty? What is

to hinder us from speaking of an electric light installation as having an insulation resistance of so many "lamp megohms"? This is shorter, and therefore more in accordance with the spirit of the times, besides being analagous to such terms as foot-pounds, watt-hours, &c., in which, while the total value or product remains constant, the factors may vary in inverse proportion.

Of course it may be argued that the insulation *is* so many megohms per lamp, as *each* lamp-holder (not lamp), with its proportion of ceiling-roses, cut-outs, switches, fittings, and conductors, has that insulation. But even granting this, the hitherto universal use of the word *per* has been in connection with figures which, when multiplied, not divided, by the number of articles referred to, give the total value. "12 feet per pound" is not the same as "12 foot-pounds."

W. S. Boult.

Chelsea, S.W., *February 17th*, 1896.

The Wiring Question.

I think that your paper deserves the support of every electrical worker in the trade by reason of the publicity you have given to this question, and I am sure that nothing but good can result, both to the consumer and the trade generally, from a full and fearless discussion of this and kindred subjects. I do not think that anyone could put the case better, on behalf of the practical workman, than "Floreat Electra" has done, and the only thing that surprises me is that he has not seen fit to join the ranks of our society, as I can assure him that we are trying to work on the lines he has so very ably laid down. Trusting this will be the means of bringing him into our ranks.

T. E. Sims.

Electrical Trades Union,
February 17th, 1896.

"Floreat Electra," in your issue of 14th inst., states the complaint of the skilled workmen, and advocates the formation of a Union, sanctioned by employers. At present a Union exists, but I have heard men warned, and been warned myself, not to join it. "If you join the Union you are done for work in London." "Please yourself, but I have not done it." "The most incompetent men we get are Union men," &c. Supposing a Union established, sanctioned by the employers, and safeguarded so that only skilled men of good character were admitted, would it prevent certain firms, more anxious for a little extra immediate profit than a good name and future work, from employing skilled and competent labour? It appears to be generally accepted that employers alone are responsible for the employment of incompetent workmen; but, perhaps, foremen are the greater sinners—sometimes for friendly, sometimes for personal reasons. Suppose there is a vacancy for a man, the foreman selects his man, but meanwhile the employer has engaged a man. That man starts work, and quickly finds his lot is not a happy one; do what he may, it is wrong, until, in despair or disgust, he throws up the job, or makes an observation which leads to his dismissal and the substitution of the desired friend. It is of no use to complain to the employer of injustice, because the foreman's statement is invariably taken, because *he* could have no interest in the man's removal, except his master's. It is absurd to contend that some of this work cannot be done by the "overflush of other trades," because it is done, and well done, daily; therefore, there must be no hard and fast lines as to pay, &c., but only as to a certain number of unskilled men on a job, and when there, confined to unskilled work.

The foreman has a greater bane than the unskilled workman, namely, the apprentice. If his own firm does not keep apprentices, he will find that some firm of consulting engineers who puts work in his firm's way does so, and always ready to supply one or more on the plea that it gives the apprentice experience, and saves the other firm a man! The average apprentice is a nuisance; he is so full of "theory" and "conceit" (chiefly the latter), that it is hopeless to try and teach him anything; moreover, he will not be talked to, because he is a "gentleman" and you but a working man. He is credited to you as a man, while, as a matter of fact, he should be put on the other side of the account, and an extra man added to look after him.

Is the incompetent workman the chief cause of the complaints from customers and central station engineers? We have lately heard a great deal of "Made in Germany." Is that not a little overdone? Is it not done, to some extent at least, to cover the sins of our manufacturers, middlemen and contractors? If you want a "cheap" article, you can be supplied by English firms as well as German. Are all things not labelled "Made in Germany" made in England? Is it not the fact that articles from Germany have their foreign labels removed, English labels substituted, and issued as "Made in England?" Are all the arc lamps made in England, or do the parts come from abroad to be fitted together, and the whole sent out as of "English" make.

The various classes of fittings are apparent to all, but I have recently had the opportunity of gauging and examining the wires used in electric lighting, and what did I find? That it was not what it was represented to be. Take Nos. 18 and 16 gauges, the diameters of the conductors of which are ·048 and ·064. I found them to be ·046 and ·062, and this reduction of 2 mils applies to other gauges. The areas, therefore, instead of being ·0018 and ·0032, are ·0016 and ·0030.

The insulation of X and X^1, or O and P (no matter for the letters) was exactly the same, and an examination of the coatings showed them to be identical. The cases cited are not exceptional, for I gauged and examined many lengths, many of 110 yards, and yet the wire was not "Made in Germany."

The complaints against electric lighting are due to several causes—bad systems, defective plans, incompetent workmen, rushed work, cheap and unsuitable fittings, and misrepresented conductors.

Establish a Union by all means, but a Union of consulting engineers, contractors and workmen, such as can command the respect and confidence of the public, and be a guarantee that the best advice will be given, good material at a reasonable price supplied, and the whole fitted up in a thoroughly workmanlike manner.

Mac.

The Durability of Accumulators.

I am glad to see that you guard yourselves in your favourable notice of the Blot accumulators by the statement that "It remains to be seen" whether they meet the desideratum of durability.

The "durability" of a thin plate of lead freely in contact with an acid electrolyte, is, I think, a matter of common knowledge. What is not so well known is that a similar conductor *embedded* in dense "active material" (as in the case of the accumulators originating with Dr. Tomassi) is to a very great extent protected from corrosive action.

Desmond G. Fitz-Gerald.

February 18th, 1896.

Important to Inventors.

It will probably be of interest to those of your readers who have been relying upon the patent law at present existing in the United States, under which they can as first and true inventor, at any time apply for protection for inventions already published in Great Britain by specifications or otherwise, to know that certain radical changes are now pending before Congress in the United States as to a revision of their patent laws.

One of the most important of the proposed changes in the United States law is to limit the time in which a valid U.S. application must be made to seven months from the date of filing of the first foreign application, which has matured into a patent, thus conforming and limiting the privileges of alien inventors to those granted by other nations in the International Convention.

The new law, as it now stands, makes no provision for postponing the date on which the same would go into effect, except that it shall not refer to applications pending in the United States Patent Office at the time the law is approved.

The new law might be passed and approved by the president at any time within the next few months, and after such law goes into effect, British or other foreign inventors would find themselves at once barred from applying in the United States for valid protection under patent for such of their inventions as might be over seven months old from the date of original application in Great Britain or in a country other than in the United States.

At present the privilege to the inventor still holds that he can obtain a valid patent in the United States at any time after their first application elsewhere, in spite of publication, provided the invention has not been *in public use in the United States* for more than two years prior to the date of making application in the United States.

Fell & James.

CENTRAL STATION WORKS' COSTS.

There is no doubt that the comparison of the works' costs of various central stations is one of the most useful things with which an electrical engineer can occupy his spare time. The costs regularly published by a contemporary would be of greater use if they always appeared as satisfactory after a detailed examination as before such an examination. Even a compilation based on "official returns" may occasionally require checking. The publication of these costs is probably leading to a keen competition amongst central station engineers, and so do good service.

The very good results published for two alternate-current stations, in two recent numbers of the journal in question, deserve attention.

The Newcastle-upon-Tyne Electric Supply Company, of which Mr. R. C. Jackson is the manager and engineer, came first with a works' cost of 1·8d. per unit, and a total cost of 2·45d. per unit, the units sold during the year 1895 being 448,832.

This excellent result was followed by the publication of the accounts of the Leeds electricity station, where the "Record" was broken with a total cost per unit of 2·05d., the works cost being 1·46d.; the units sold for the year being 524,629, somewhat larger than at Newcastle. It is obvious that a difference of about 20 per cent. in the total cost per unit—a difference bringing the total cost down from 2·45d. to 2·05d.—must be very well worth obtaining, and we eagerly compared the records in order to find how this very large percentage economy was effected. This difference is only in part to be explained by the more favourable conditions at Leeds as regards the revenue per lamp, this being 8s. against 6s. 1d. at Newcastle. On searching for a further explanation of the difference, we were somewhat disappointed to find that it has apparently been effected by the modern Irish expedient of paying no rent, rates or taxes, or, at any rate, paying only a very small amount. We think that if this lesson from the "Plan of Campaign" can be applied generally, it will do more than anything with which we are acquainted to improve the prospects of electricity supply companies. We find that Mr. Jackson has apparently been under the unfortunate necessity of having to pay £392 7s. 6d., for rent, rates, and taxes, which, distributed over his year's sales, comes out ·21d. per unit sold; whereas the much more fortunate Leeds Company, although doing a larger business, by acting on the admirable "Home Rule" plan, has got off with the trifling expense of £65 11s. 6d. for the year, which, being distributed over the sales, comes out only to ·03d. per unit sold. As it is, of course, impossible to believe that £65 11s. 6d. is a correct figure for the rent, rates, and taxes, of so large a concern, the comparison becomes misleading or useless. Our contemporary pays a tribute to what it calls "the sound commercial lines upon which the Leeds directors are conducting the company's business," and we certainly agree that the results are excellent, even if the decimal place has gone astray in the item we cannot accept.

We should much like to see a common basis arranged by electrical engineers for the display of working and capital costs. The rent (whether rent proper, or interest on capital expended in purchase of sites), should be clearly stated, and should be distinguished from rates and taxes so as to allow of a separate comparison of these items.

The cost per unit generated, as well as the cost per unit sold, should always be given, the proportion between these quantities being very important—being useful especially in enabling the different systems to be compared. On the vexed subject of repairs and maintenance there is great difficulty in getting a useful comparison, the standard as to the conditions of plant, whether in or out of the station, differing so widely in different stations. Good apparent results may be got for a year or two, but sooner or later the day of reckoning has to be faced. Then in some stations the directors are interested as contractors, and allowances must be made for human nature. The amount of such allowances is probably impossible of determination. It would mostly affect the repairs and maintenance returns, but would show also in the coal consumption. In some works it is known that a large amount of coal is burnt by the watchmen and other non-steam-producers.

These and other matters it is easy to criticise, but difficult to arrange on a common basis. We commend the subject to the notice of the borough and central station electrical engineers when next in council assembled.

UNITED KINGDOM TELEPHONE DEFENCE ASSOCIATION.

We have received a set of circulars, now being sent out by the above Association to telephone subscribers and others in the United Kingdom, with the object of enrolling members at a subscription of 5s. This subscription will entitle members to the advice of the Association in any complaints they may have against the telephone service. The probability, therefore, is that the Association will be kept busy, and the subscription at least well earned; but that it will do any practical good we doubt. The prospectus (and other papers) are very plausibly compiled, and will certainly mislead a number of people; but for effective good in the direction aimed at, it is essential that there should be a recognition of facts, and a scrupulous regard to accuracy in stating them. The comparisons with other countries are really valueless, because they omit the difference in conditions. In representing Christiania under the heading of municipal control, it should have been stated that the control arose from the Council compelling competitors to combine in consequence of the public disadvantages of competition. We should like to have some further information as to the working of the municipal system at Trondhjem, but as to Rotterdam and Amsterdam, we feel that the omission to state further facts seriously influences the value of the information. These municipalities have always had telephone rights. They issued licenses. The licenses are close upon expiry, and they have decided to work the system themselves. These towns are, therefore, in exactly the same position as the British Post Office will be in 1911 if they do not previously purchase the existing system. The comparison with English municipalities is futile. If they obtain a license, they must either purchase the service in their locality, or run in competition. The advantages which are stated to have accrued from competition are not free from the necessity of examination. No importance need be attached to reduced rates of subscription supposed to be ensured by the last words of an expiring telephone company. We note that the competition in Manchester which expired as the New Telephone Company reverts to the original Mutual Company. Amongst the benefits which have been gained for Manchester is included the system of switching "introduced" by the Mutual Company. We believe that Glasgow has received a similar benefit, but Glasgow does not yet seem quite happy, and we think it a little early to assume the benefit in Manchester. As to the competition of the New Telephone Company, the less said the better, and the claim that the action of the older Protection Association was productive of good we fear cannot be borne out. The "concessions" said to have been obtained by that body were

either non-existent or practically valueless whilst the evil which it did by acting as a recruiting ground for the New Telephone Company, and facilitating their financial arrangements, is not to be overlooked. The executive council of the present Association (amongst which there are important names) should be careful to avoid any possibility of similar results. The prospectus and the "statement" should be revised. The council should, as far as possible, inquire into the facts for themselves, and not rely entirely upon information submitted to them. Their statements to the public should be carefully freed from any point liable to misconstruction—and then possibly they might influence public opinion with advantage.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

At the ordinary general meeting held at the Institution of Civil Engineers on Thursday, February 13th, Dr. John Hopkinson, F.R.S., president, occupied the chair.

The formal business having been transacted, and the secretary having read an acknowledgment from the Home Secretary of the Institution's resolution of condolence with Her Majesty the Queen and Princess Beatrice, the discussion on the papers on wiring, read by Mr. Sam Mavor and Mr. Bathurst, was resumed.

Mr. J. D. F. Andrews said he proposed devoting his remarks entirely to concentric wiring. Mr. Mavor was good enough, in reading his paper, to attribute the pioneership of that system of wiring to him (Mr. Andrews), and he had pleasure in thanking him for his courteous remarks and acknowledgment. He might add to what Mr. Mavor had already told them, that his almost daily practical experience in connection with it had extended over 12 years. The invention or conception of concentric wiring, even with a bare outer, was not in itself a matter which required much ingenuity; but, at the time it was first introduced, it was directly opposed to the then existing ideas and principles, and its introduction was met by great opposition, more especially by the insurance offices, which at that time almost unanimously followed the Phœnix rules. It was a relief, however, to be able to say that that opposition had now begun to die out, and it was a matter of no difficulty whatever to satisfy insurance offices; in fact, most of the offices regarded it in its true light, an additional safety. He might mention, in compliment, that Mr. Human, of the Guardian Office, was the first surveyor to recognise the advantages of the system from an insurance point of view, and having once gained the good offices of a gentleman who so thoroughly understood the subject, he was soon able to gain the sanction of the majority of the offices. He was sorry to hear Mr. Mavor make proposals regarding inspection by the insurance offices. He thought their policy of trusting to a great measure to the contractors, whose reputation they knew to be at stake, a very convenient one, and he did not think it should be suggested that the English contractor would take mean advantage of this trust. This tendency of the insurance offices, moreover, was a proof that they regarded electric lighting as quite a minor source of risk, and that it was unnecessary to employ special skill, and issue elaborate rules. The Board of Trade had also begun to show a more generous inclination in a direction that would give a wider field to the introduction of concentric wiring. He might, in fact, say that negotiations were progressing satisfactorily with them for his system of concentric mains with a bare, or nearly bare outer conductor, to be laid in the streets of Guildford by the Guildford Electric Supply Company. The system there to be introduced was the three-wire, consisting of two independent armoured conductors, the armouring of both of which combined formed the middle wire. Bare concentric wiring for street mains had advantages for all systems of current supply, two-wire continuous or alternating, or three-wire. There were, however, special points to be observed in each case. A three-wire system and continuous currents might consist of two armoured cables laid preferably side by side with the two armourings joined together at intervals, say at each house connection, so as to avoid possible electrolysis between them. With alternating currents and a three-wire system, the two outer conductors of the system must be enclosed in one armouring, to reduce the induction. In both cases the armouring would be smaller in section than with a single two-conductor concentric system. With an earthed concentric system, a very much more perfect balance could be maintained than in the case with three separate conductors, because it was a much less complicated undertaking to run the three-wire system into buildings, and consequently, it could be applied to smaller installations, in each of which there would be two ordinary concentric circuits. The wide introduction of concentric wiring would prove to be of enormous benefit to the electrical industry at large; it considerably reduced the cost of street mains; and the cost of service joints would be less than a quarter the price of the present joint box arrangement. The greatest advantage, however, would appear in the reduction of the cost of interior wiring, which would be considerably less than with casing or conduit systems, quite 20 to 30 per cent. The wide introduction of concentric wiring was dependent upon a universal permission to earth the distributing network, a permission that would not alone be good for concentric wiring but would also be beneficial to all systems of street mains, and everything within range of their influence, for the simple reason that the course of leakage currents would be reduced practically to the distance between the two conductors instead of, as now, the course being of unknown distance through earth, and consequently unlimited influence on everything in the course, such as telephones and pipes. To put the principle concisely, if a leakage occurred in a house it would be confined to that house, and would probably cure itself by blowing the fuse. By earthing the network he did not mean that it should be earthed only at one point; on the contrary it should be almost continuously earthed, or at each house connection. By earthing one of the street mains he did not advocate that it should be bare; on the contrary it should be protected against electrolysis and possible chemical action of the soil. The earth connection only should be exposed. The benefits of such a self-testing system to supply companies now using the non-earthed system would, he was convinced, entirely outweigh the cost of making the conversion. With concentric wiring earthed there could, of course, be no leakage currents through earth from wire to wire, and current due to the difference of pressure between one point and another of the outer conductor could be reduced to nothing by a light covering. The feeders to an earthed network would have to be insulated at the dynamo end, and earthed only at the network end. He understood from various sources that earthed three-wire systems in America and Germany had proved most successful. This concentric system depended for its great benefits, more especially as regarded safety, upon two main features. The outer conductor should be absolutely continuous from the dynamo to the lamp; it should be of large section, and entirely envelop the central conductor, also the switches and the fuses. It should be in such close proximity to the inner conductor that it would be impossible for an arc to be established without blowing the fuse. Following those fundamental principles was the only method by which the great advantages of the system could be secured, the reason for which would be obvious when they considered that if the inner conductor was exposed, or easily reached at any point, it would be possible for leakage to take place from it without first touching the other conductors. Although Mr. Mavor had flattered him by following and adopting his devices in almost every part of his system, he was sorry to note that in certain other points his modifications deviated rather considerably from the foundation principles which he (Mr. Andrews) had already stated. In introducing a new system like that, it would be a great boon to the trade if the designers would agree upon fixed definite lines. There was a board of samples present illustrative of the system as he recommended it, from which it would be seen that every part of the system was enclosed within the outer conductor, with the full thickness of the outer completely surrounding the inner, switches and fuses included. If concentric wiring were to become general, two important changes might be looked forward to in wiring practice; the test to earth would vanish, and the high degree of insulation now required between the conductors would be looked upon as absurd. The insulating material in a concentric wire should be substantial in character, and highly durable, but it was only required to insulate to such a degree as not to permit of a greater leakage to take place than might be negligible from a commercial aspect, if it could be possible to obtain reliable insulating material to work at so low a degree; for instance, a wire of 10,000 ohms per mile would only mean a leakage of $\frac{1}{100}$th of an ampere with 100 volts. He did not advocate that as the correct degree of insulation to be adopted, but simply gave it as an illustration, and he would point out that it was 60,000 times lower than was at present insisted on in most double wiring. Of course, they were accustomed to very low insulation tests on house installations on the double wire system; that, however, was due to the intricate nature of the system, and great number of exposed points, not to the length and quality of the wire. With concentric wiring, on the other hand, the tests were generally in proportion to the length of the wire before the fittings were installed.

Mr. Wallis-Jones said it was somewhat interesting to look back upon the progress of electrical wiring since, say, 1881. He thought if they looked at the question broadly, they would find that the art of wiring had really divided itself into three distinct periods. They might almost say there was the stone age, the wood age, and the iron age. If the progress shown continued to follow the progress of civilisation in other directions, then probably the iron age had come to stay. The great difficulty in installation work was the question of moisture. If there was absence of moisture, almost any kind of wiring was good enough. He might instance a case in his own experience some ten years ago. They had to wire a new building. In those days, as they well knew, there was no such thing as vulcanised wire in general use. The wires in this installation were simply covered by a pure rubber strip, cotton and tape, and he was not at that time certain of the action of various cements and mortars upon the insulation of wire, but he did know this, that the action of plaster of Paris on bare wires was at least harmless, and he buried those wires in channels cut in the walls, and fastened them in with plaster of Paris. At the present moment, that installation would give as high a test as any he knew of. That was simply an instance proving that where you had no moisture you could do with very light insulation. One of the greatest difficulties of wood casing was the very great uncertainty of the action of damp on the cable inside. He knew one case in particular, in which a 19/16 cable was absolutely wasted, so that the conductor was dissolved right away, and nothing remained but the copper salts. This, on being examined, was found to be caused by a very poor class of insulation around the conductor and damp attacking it. The wall on which the cable was placed had become damp by the bursting of a water-pipe. In new buildings, however, before the advent of the insulated conduit system he had seen very successful work carried out with wood casing thoroughly well varnished and put in of a size larger than was absolutely necessary to carry it away. The casing should be buried and plastered over and the conductors drawn in after, in that way

they would find they could get a fairly good job. No doubt in a wood casing installation there were many mechanical difficulties which were unavoidable; for instance, in going through the walls of the house they put the conductors in porcelain tubes or rubber tubes. These were merely makeshifts. The question of insurance had been touched upon. It seemed that the question of insuring central stations was considered by the fire insurance offices from a very unfair basis at the present time. They made no allowance for the difference in the class of building, but charged one rate whether it was a well-designed or badly-designed building. In one large central station in this country they had taken the matter into their own hands by simply refusing to pay the fire insurance premium and fitting up the station with a proper fire extinguishing plant. In regard to insulated conduit systems, he had had practical experience of an installation of about 800 lamps. As they well knew there were three classes of these conduits; first, the plain bitumen tube, secondly, the brass-armoured tube, and then the iron armoured conduit. The first was somewhat fragile, not fireproof, and certainly not very sightly when fixed in position on the surface. There was also an intermediate type of conduit, which consisted of an insulated tube covered with an iron split tubing. The difficulty in using this appeared to him to be in the jointing, and consequently he was not at all sure that it would be waterproof; that was to say, he did not think the inner tube could be guaranteed in all sections. However, he thought that so far as present knowledge went, if they had to wire a new building with the two-wire system, there was no system as good as the solid iron tube insulated conduit, and for this reason, that they could take the building in the carcase, and place the iron pipes readily in position, plaster the whole of the work up, and draw the wires in when they had finished, and they might be quite certain there would be no trouble from bad insulation. As an instance of this, he might mention that in this particular installation which he had experience of, he tried the other day the experiment of placing a plain steel tape into the conduit for a considerable length. The insulation of that plain steel tape was practically infinity, and therefore even every poorly insulated wire would give very good results indeed. He thought the system of insulated conduits, as at present designed, could quite possibly be improved upon in various details. The general way of carrying out work at the present time was to run from the central switchboard a main to a fuse distribution board, and from this fuse distribution board circuits for seven or ten lamps were taken off. Wherever a joint was made, a joint-box was inserted. But he thought the best way of doing work of this kind in the future would be to run the main to this fuse board, and from the fuse board run a submain to a fuse and joint box, and then run into this fuse or joint box the seven or ten lamp circuits, having no joints at all in the system. Twin wires should be used. He had had the pleasure of inspecting the details of the concentric wire system as shown by Mr. Mavor, and he thought that where they could have an isolated or separate transformer plant, it was a most admirable system, and one destined to be largely used in the near future, but he did not think it was a very sightly one if they were obliged to place it on the surface. When Mr. Mavor mentioned sightliness in houses, he was probably thinking of Scotch houses, where there were hollow walls and they could run the wires behind. In houses where the system would be placed on the walls it would be a very difficult thing to get a straight line with any flexible conductor such as they had in the concentric system. He had looked into the question of the possibility of drawing wires into this insulated conduit system, and found, of course, that they could most easily draw in a considerable length. Powdered soapstone blown in the conduit assisted the drawing in of conductors. He should say the average length desirable for circuits was about 60 feet to 70 feet from distributing point, and he found that the total drawable area of the wires, that was to say, taking the added areas outside the insulation as compared with the inside area of the conduit, the average was something like 45 per cent. There was one way in which the conduit could be improved, by reducing the diameter. This was an important point in the question of cost, because unless they had a fairly small conduit they had to chase so deeply into brickwork that it became exceedingly expensive to instal it. From that point of view, of course, the concentric system had a great advantage.

(To be continued.)

The Société Internationale des Electriciens.

The monthly meeting of February 5th was occupied entirely by a conference held by M. Perrin on the Röntgen rays and the photographing of opaque bodies. M. Perrin first showed all the power of the cathodic rays, and quoted Crookes's opinion concerning them. He referred briefly to the powerful new means of investigation added to science by the X, or Röntgen rays. He then spoke of the phenomena of discharge *in vacuo*. If we put two electrodes into an egg, and produce a vacuum, we get a luminous column, and at one extremity Faraday's dark space. We also see in another receiver Crookes's space. On increasing the vacuum we see a phosphorescent glow at the negative pole. M. Perrin showed the different phenomena in a Geissler tube or a Crookes tube in the same circuit. The phosphorescence depends solely on the place of the cathode, whatever that of the anode may be. It is the cathodic rays that are thus produced. These rays are reflected; they undergo the action of a magnet, and exercise mechanical actions on a little mill, which they cause to revolve. Some German physicists demonstrated the phenomenon, assuming vibrations in the ether. Some English physicists, such as Crookes and Lord Kelvin, explained it by the theory of radiating matter. The particles were repelled from the cathode. Hertz and Lénard showed that the cathodic rays passed through very thin metal plates, for instance, a sheet of aluminium, $\frac{1}{100}$th of a millimetre in thickness. It then seemed difficult to believe in the passage of particles of matter when air could not pass. Thomson found for these rays a speed of 200 kilometres per second. These figures were low if we assume undulations, and high if we assume the existence of particles of matter. M. Perrin thinks that he has found in a Crookes tube two fluids of an opposite nature, one positive the other negative. He would thus be inclined to an electrolytic hypothesis with regard to the existence of these rays. The speaker then passed on to the Röntgen rays. If before a Crookes tube wrapped in black paper we place a screen impregnated with cyanide of barium, this tube becomes luminous, and a photographic plate receives an impression. If between the tube and the plate we place objects, such as the hand, wood, &c., these objects are photographed. M. Perrin made an experiment during the conference, and took a photograph of a key. He then showed various proofs obtained; a bunch of keys, compasses in their cases. He showed a phosphorescent effect with the help of a screen. He demonstrated that in order to obtain these impressions the object must be placed at a short distance from the Crookes globe, above a frame enclosing the photographic plate. The duration of the pose varies according to the distances. For the transparence of the various media there is no general rule. Wood, flesh and cardboard, are very transparent; carbon and bone are less so; metals are to a certain extent transparent according to their density. As regards the thicknesses to be traversed, there is a difference with the cathodic rays. These would be arrested by a slight thickness of aluminium, and the Röntgen rays would not. The Röntgen rays are propagated in a straight line, and are not displaced by a magnet. There exist certain analogies between the Röntgen rays and the ultra-violet rays. The Röntgen rays do not undergo reflection, refraction, or any action through the influence of the magnetic field. Experiments in diffraction gave no result. If, therefore, the Röntgen rays are ultra-voilet, they are extreme ultra-violet rays. We may add that M. Lippmann has just discovered that the Röntgen rays discharge charged bodies. The theory of this new phenomenon is difficult to enunciate. Prof. Schuster imagined that it was due to a prolongation of the ultra-violet light. Röntgen sees a particular mode of action, and supposes that it is connected with the longitudinal vibrations of the light. M. Poincarré sees in it a new phenomenon. The practical results are already very numerous. M. Perrin showed several impressions of a jugular vein of the arterial system of a frog with mercury injected, of the bony skeleton of a fish, and of a frog. The Röntgen discovery will be a fruitful source of applications.

LEGAL.

The Edison & Swan United Electric Light Company, Limited, *v.* Williamson & Joseph.

This action was before Mr. Justice Romer in the Chancery Division of the High Court of Justice on Friday and Saturday, the 14th and 15th inst. It was an action by the plaintiffs, who carry on business in Queen Street, Cheapside, in the City of London, to obtain an injunction restraining Messrs. Williamson & Joseph, of 92, Queen Victoria Street, from selling or disposing of holders or sockets for incandescent electric lamps, made in accordance with certain patents, for less than the retail prices quoted by the plaintiffs in their current price list for similar goods. Mr. Fletcher Moulton, Q.C., and Mr. Eve, Q.C., appeared for the plaintiffs, and Mr. Gatey for the defendants.

By the statement of claim it appeared that the plaintiffs are a company incorporated under the Companies' Acts, and are entitled, under certain letters patent granted to Joseph Wilson Swan, to Edward Hibbard Johnson, and to Carl Dornfield in 1881, 1882, and 1884 respectively, and of which the plaintiffs are assignees, to the sole and exclusive privilege of making, using, and vending these holders or sockets. By an indenture of July 1st, 1890, made between the plaintiffs of the one part, and Messrs. Appleton, Burbey & Williamson, the licensees, of the other, the plaintiffs granted to them full, but not exclusive, license to use and apply the inventions comprised in the said letters patent, and to use and sell these holders or sockets. And the licensees covenanted with the plaintiffs to pay them a royalty of 10 per cent. on the company's retail prices on all holders or sockets made by the licensees under the license, and a minimum royalty of £50 per half year. The defendants were the successors in business of the said Appleton, Burbey & Williamson, and it was alleged that they had committed a breach of their covenant by selling at less prices than quoted by the plaintiffs. In particular, it was alleged that on May 17th last they sold to one John Clark, a parcel of 50 holders at the lowest retail price quoted by the plaintiffs, less the greatest authorised discount, and in addition had made a gift to Mr. Clark of eight holders or sockets, equal to a further cash discount of 16 per cent.

Mr. Moulton observed that this was a matter in which perfect good faith must be observed among the licensees, else one selling at a lower price would be likely to get the whole of the trade. It was a duty cast on the plaintiffs to proceed against anyone for breaches of the restriction contained in the licenses. They asked for an injunction, and with regard to damages he submitted they were entitled to an inquiry. This was a case in which they were unaware of the full extent of the breaches.

Mr. Justice Romer inquired what the defendants' contention was.

Mr. Moulton said they were going to say that these were not holders or sockets of a similar description to those manufactured by the plaintiffs.

Mr. Gatey said the defendants intended to raise that point. They were admitted to be articles not manufactured by the company. They were manufactured by the defendants.

Mr. Justice Romer: But the question is whether they are of a similar description.

After hearing the evidence, the defendants on their side saying the particular transaction was entered into without their knowledge and consent, and contrary to their express instructions,

Mr. Justice Romer said he accepted the testimony of the plaintiffs' witnesses.

Mr. Gatey signified the willingness of the defendants to give an undertaking to abstain from a repetition of the acts complained of.

Mr. Justice Romer said there was a discrepancy of evidence, but as he had said, he accepted the testimony of the plaintiffs, and he must say that he thought Mr. Joseph, Mr. Condon, and Mr. Williams, were mistaken in their testimony. This was a case where admittedly there had been breaches of the license previous to March, 1895. Since that time a further breach had been proved. He thought they communicated to their employés the fact that no greater discount should be allowed than 33⅓ per cent. He was not satisfied that there was only one instance of breach. Nobody could follow the transaction completely. He should say no more about it, seeing that the defendants had offered an undertaking which the plaintiffs accepted. The defendants tried to escape from the action by asserting that the holders which they had been selling were not of a similar description to those manufactured by the plaintiffs, and included in their price list. There was a difference between them; but it was not a material difference for the purposes of this case. The holder was similar to the holder sold by the company, and mentioned in their price list. He was supported in that view by the fact that the defendants and their employés always treated the holders they sold as similar to the plaintiffs'. He need add no more after what had passed, except to say that he awarded the plaintiffs 40s. nominal damages instead of an inquiry, the plaintiffs being willing to adopt that settlement. The defendants would, of course, pay the costs of the action, but no order would be made as to the costs of the interrogatories.

Judgment for plaintiffs accordingly.

South Staffordshire Tramways Company *v.* Ebbsmith and Wain.

In the Queen's Bench Division on 12th inst., the trial of the action, South Staffordshire Tramways Company *v.* Ebbsmith and Wain, came before the Lord Chief Justice and a special jury. Sir F. Lockwood, Q.C., and Mr. Charles Mathews, appeared for the plaintiffs; Mr. Kemp, Q.C., and Mr. Bowers, for the defendant, Mr. Carruthers Wain; and Mr. Ebbsmith appeared in person.

In opening the case, Sir F. Lockwood said that the statement of claim alleged that the defendant Ebbsmith was solicitor to the company and its predecessor, and the defendant, Mr. Carruthers Wain, was a director and chairman of the company, that both the defendants were in a fiduciary position to the company, and that in breach of the duty imposed upon them in that position they sold worthless patents to the company, and made secret profits, and packed the meetings of the company. The plaintiffs claimed damages. The defence was a denial that the defendants were in a fiduciary position, and that they had committed any breach of their duty. The plaintiff company came into existence in 1882, and in 1889 it became a limited company. From 1882 to 1889 Mr. Ebbsmith, who was a solicitor then practising at Wednesbury (who had changed his name from Smith to Ebbsmith), acted, first, as local solicitor of the company, and subsequently as solicitor generally to the company, and during those years he was being instructed by the company with regard to its operations. The name of his firm was Smith & Son, and Mr. Joseph Smith (as he was then) was an active member of the firm. From 1885 the other defendant, Mr. Wain, acted as chairman of the company, and continued in that capacity down to 1894. At that time, after an investigation by a committee of shareholders, Mr. Wain ceased to act as chairman of the company. In the statement of claim, the charges resolved themselves under three heads. First of all, it was alleged that Mr. Ebbsmith, in the matter of the sale of a piece of land to the company, betrayed the trust imposed upon him as solicitor of the company. It was said that he did this with the consent and with the assistance of Mr. Wain, that he disposed of a piece of land to the company which was Ebbsmith's property without disclosing to the company his interest in that land, and that he disposed of it at a price which was largely in excess of its value. It was further said that whilst holding these positions these two persons palmed off upon the plaintiff company certain worthless patents; that these patents, which were obtained in some cases directly from Mr. Ebbsmith, were sold at large prices to the plaintiff company, and that large sums were also obtained by reason of royalties which had to be paid under agreements made with the plaintiff company. In the third place it was alleged that for the purpose of carrying out the desires of Ebbsmith and Wain from time to time, it became necessary to pack the shareholders' meetings, and that for that purpose qualifications at these meetings were obtained by Ebbsmith. Sums of money were taken from the company to pay for the conveyance of such shareholders, who were brought under circumstances, which would be given in evidence, to the meetings of the company, and used for the purposes for which they were brought. He need only say that something like £400 was expended in this way, a number of shareholders being brought down from London in saloon carriages, and returned to London in the same manner, and liberally entertained —too liberally, in some cases—out of the moneys of the company.

Henry Hatchett was then called. He said he was appointed assistant secretary to the Limited Company on July 1st, 1885, and secretary in September, 1885. Mr. Ebbsmith was local solicitor to the company up to 1887, when he became general solicitor, which position he resigned in 1889, but remained Parliamentary solicitor for some time longer. Mr. Wain was appointed chairman of the board of directors in 1885, and remained in that position till 1894, when he held £250 in preference shares and about £100 stock. A circular was issued by Mr. Ebbsmith in reference to the goods traffic, and asking the shareholders to sanction the formation of a goods traffic company in connection with the tramway company. At a meeting on August 5th, the question of the goods traffic was much discussed, and the two defendants spoke at length, but made no reference to the objections made by local authorities. Mr. Ebbsmith was asked to say what the profit on the goods traffic had been, but whilst replying that the profit was considerable, he declined to state the amount, although it had been reported by the manager, Mr. Dickinson, to have been, up to July 15th, £45 only.

Correspondence was next read as to the land for the goods depôt.

Witness said that £5,500 was paid for the site by cheque and £1,640 in bills.

The hearing was continued the following day (Thursday), when Mr. Hatchett, the secretary of the company, continued his evidence, and bore out the opening statement with regard to the patents and the shareholders who came from London. He was cross-examined by Mr. Ebbsmith, who suggested that Messrs. Webb & Co. were the real solicitors of the company from 1882 to 1887, Joseph Smith & Co. being merely their agents on the spot. The number of shareholders present in person at the meetings of the Dickinson Company was usually about six, and it was suggested by Mr. Ebbsmith that the special shareholders were obtained by him to ensure a quorum, in compliance with the standing orders, at the time the Bill of 1889 was before Parliament. Mr. Ebbsmith also suggested to the witness that he had in 1887 pointed out to him that he could not himself act in the sale of the Wednesbury land to the company, but that the sale was hurried on by the directors, who were anxious not to delay the issue of debentures, of which he was taking £4,000. The witness did not confirm this, though he thought it was once suggested that another solicitor should be employed. There was no trace of Mr. Smith's objections being laid before the board.

Cross-examined by Mr. Kemp, Witness said that Mr. James, Mr. Davison, and Mr. Busby were also directors in 1885 and onwards, Mr. Lloyd joining later. They attended regularly. None of the directors knew what Smith had paid for the Wednesbury land. The lease was first purchased, but it contained building covenants not suited to the purposes of the company, and the land was acquired at 20 years' purchase.

Re-examined: He did not suggest that Mr. Smith made any objection to receiving the purchase money of the Wednesbury land. Only Mr. Davison was living, of the directors he had mentioned. Of the persons present at the shareholders' meeting in March, 1889, much the larger number came from London.

Evidence was given as to the value of the 3½ acres at Wednesbury, which were said by a local auctioneer to be worth about £700. Evidence was also given to the effect that the patents mentioned were by no means worth the sums paid for their use.

When the Court resumed on Friday, further evidence was given with regard to the Wednesbury land, and the patents on which royalties were paid by the limited company. It was stated that the land at Wednesbury was quite unsuitable for a goods depôt. Evidence was also given as to the excessive amount of the royalties paid, and the unsatisfactory character of the patents.

Mr. Samuel Tompkins, examined by Sir Frank Lockwood, said that he was appointed liquidator of the Corporation Trust by the shareholders. The Trust was founded in 1889, and he became secretary in 1891. Wain was chairman, and the directors were Wain, Rose (Smith's partner), and a Mr. Stansfield. The offices were at Smith's offices, and the company went to allotment with a subscribed capital of £1,000 in founders' shares, and £300 in ordinary shares, out of a nominal capital of £50,000. The objects of the Trust were to finance companies and to lend money. Subsequently, in 1891, £6,000 more shares were issued, of which £5,000 were issued to Mr. Dickinson, who paid cash for them. On the same day Smith offered the Trust £5,000 worth of shares in the Electrical Construction Company, which the Trust bought. In December, 1889, debentures were issued for £15,000, in exchange for £15,000 debentures of the Dickinson Company. The debentures and coupons were to bearer, and the coupons were paid to Wain. The interest was drawn in three cheques at a time. At the winding up in 1892, Ebbsmith was a creditor as to £7,500 of these debentures, and a further £100 debenture; Wain was a creditor for £2,500, and Dickinson for the remaining £5,000. The minute-book was produced, and the witness was asked to explain an erasure which occurred at a critical place. He thought it was a mere correction. The book was in Wain's custody in March last, and it was said to have been lost, having been removed from a box which had been broken open. Witness received it a day or two before the trial from his solicitors, to whom it had been returned by Wain. The Corporate Trust was reconstructed as the European Contract Company. Wain was chairman. The creditors, Smith, Wain, and Dickinson, took debentures instead of the debentures in the Corporate Trust, Limited.

Evidence was given as to other sums paid to Dickinson & Co., for patented articles, and as to the purchase of the Wednesbury land.

Mr. Ebbsmith, addressing the jury, denied that the circumstances connected with the sale of the Wednesbury property to the company were in any way kept secret. He actually showed his lease to the secretary of the company, and told him what profit he was making. The profit was large, but very considerable sums had been expended by him on levelling and draining the land. With regard to the patents, he bought the road and rail car from Dickinson. He thought it good, and did not know where it was made. Various claims were made to it, and ultimately he bought it for £50, instead of one-third of the profits as first arranged. Later, it was arranged that they should combine to work the patents together, and the company was formed. There was no secrecy in the matter. The company's offices

were at his own office, and the name of the company was the name of the inventor. The patents were openly transferred into the name of the company. It had been said that he rewarded the fraudulent co-operation of Wain by getting him a valuable post in the Birmingham Central Tramways Company. It was true that he did secure him the post of manager to that company, but, as the agreement showed, his salary, except as to £100 for expenses, depended entirely on the profits which might result from his exertions.

On Monday, Mr. Ebbsmith concluded his address to the jury, and further submitted that the Statute of Limitations applied to all transactions previous to January, 1889, while after April, 1889, he resigned and ceased to have any fiduciary relation to the company.

Mr. Kemp having spoken on behalf of Mr. Wain,

Mr. Joseph Ebbsmith was sworn. He said that, though appointed as sole solicitor in March, 1887, he did not so act, but only acted in those matters in which he was instructed. In 1885 he became interested in Dickinson's patents. The lifeguard was his own invention, and the Dickinson Company were appointed sole agents for it in 1890. He had no association with the fish and sole plates patented by Dickinson after witness left Wednesbury. He wrote a letter to the company previous to the purchase of the Wednesbury land, saying that the price asked was based upon the ground rent. At the time that letter was written the company were already his tenants, having purchased the lease from the Dickinson Company. He had no share in inducing the company to purchase that lease, and he was himself of opinion that the land was unsuitable. In what had been described as packing the meetings he considered that he acted in the best interests of the company.

Cross-examined by Mr. Kemp: He did not think he actually advised the directors that they needed no consent for goods traffic, but that was his strong opinion at the time.

Cross-examined by Sir Frank Lockwood: He did not think he had received from the plaintiff company in costs between 1882 and 1889 over £5,000. He could not say how much it was. For direct payments for patents he received nothing. From the Dickinson Company he received £2,250 in dividends of the Dickinson Company during 1887 and 1888. In 1889 the Corporate Trust received the dividends. In the autumn of 1887 there had been objections from some of the local authorities as to the goods traffic, but he did not consider them of enough importance to be mentioned in his speeches or in the prospectuses. He admitted that he and the Dickinson Company were one: he had always proclaimed it. His negotiations with the Dickinson Company with regard to the lease first appeared in their books on March 28th, 1887, when the secretary of the company presented the counterpart lease from him, and also reported the offer of the tramways company to purchase the lease for £100. The matter of the lease appeared to have been "rushed through," and it bore the interpretation that its object was to show that a groundrent had been created. Witness was then taken through the transactions in connection with the Dickinson Company, the Corporate Trust, and the division of debentures between Wain, Dickinson, and himself.

He called no other evidence.

General Hutchinson, formerly Inspector of Tramways to the Board of Trade, said that he examined the life-guards and additional brakes of the South Staffordshire and Birmingham Central Tramways Company, and was satisfied that they were suitable for their purpose.

Mr. Neale, chairman of the Birmingham Central Tramways Company, examined by Mr. Kemp, thought Wain was introduced to him by Mr. Moore, the previous chairman. The gross receipts rose from £100,000 to about £150,000, owing largely to his management, and the directors were well satisfied with him. The shareholders thought he was getting too much, but his large salary was owing entirely to the rise in profits brought about by his own exertions; £100 a year was paid, he thought, for the use of the life-guard by the Birmingham Company. He did not know that it was the property of Mr. Smith, and he never knew, till he heard it in Court, that Mr. Smith had any connection with the Dickinson Company.

Mr. Carruthers Wain, the second defendant, was then examined by Mr. Kemp. He said he was a civil engineer, and was first connected with the South Staffordshire Tramways Company in August, 1885, Busby, James, and Davison being then directors. They were all men of great experience. The Company was then on the verge of liquidation, but was still being carried on. Mr. Ebbsmith, then the local solicitor, advised the directors that the consent of the local authorities for goods traffic was unnecessary. The land at Darlaston was not suitable for a goods depôt. The directors inspected the Wednesbury land. Witness knew that Smith had a large interest in it, but he did not know that he was the owner, nor what price had been given for it. He did not know how the lease came into existence. There was no bargain by which witness was to profit by the sale, nor was his Birmingham appointment in any way connected with the transaction. Witness knew that the defendant Ebbsmith had a controlling interest in the Dickinson Company by the interest which he took in the patents. In October, 1889, he received £2,500 worth of debentures in the Corporate Trust. Witness thought that the sale of the patents might be pushed abroad. The £2,500 debentures were given as an inducement to him to endeavour to make the foreign patents of value to the trust. Witness was a founder of the trust. The debentures were then worthless paper.

On Tuesday, Mr. Wain was further examined by Mr. Kemp, and cross-examined by Sir Frank Lockwood.

Mr. Kemp then addressed the jury, and Sir Frank Lockwood replied.

The Lord Chief Justice, in summing up, said the charge against the two defendants was this—that, while each held a position with regard to the plaintiff company which demanded faithful service, they conspired together to abuse their position for their own profit. After going at considerable length into the various points, his Lordship said the packing of the meetings was undoubtedly a misappropriation of the money of the company, but the moral complexion might be viewed in two very different lights. Was that an honest, but illegal, use of the company's money, or was it a corrupt misappropriation to further the private ends of the defendants? The jury must say—(1) Did the defendants agree to act in concert together in fraud of the company and for their own benefit, or the benefit of either of them, in the purchase of the land? (2) The same question in respect of the patents. (3) Was the money paid to the shareholders at the packed meetings an honest illegal payment, or was it a dishonest appropriation? Having first considered the liability, they must then consider the amounts by which the company had been damnified, if at all. His Lordship went through the items which had been proved, and the jury retired.

After an absence of an hour and a quarter they returned. They found against the defendants on the land question—damages £7,313 (being purchase money and costs), and interest at 3½ per cent. from 1887. They found that there was conspiracy in the matter of the patents—damages £2,100. They also found that both defendants had been guilty of corrupt misappropriation in respect of the payments to shareholders—damages £362, with interest at 3½ per cent. The foreman added that they looked on this only as a return of the money, and asked if they could give damages in addition for the wrong done by the defendants to their employers.

The Lord Chief Justice pointed out that the sums lost to the company were the damages. He would consider the following morning how judgment should be entered.

The jury were released from serving for three years.

Gaskell *v.* Gosling's Appeal.

On Friday morning last their Lordships announced that they would take time to consider their judgment in this case, a report of which was given in our last issue.

BUSINESS NOTICES, &c.

Action for Damages.—In the Common Law Division of the Manx High Court, on the 13th inst, the action of Geo. Crellin against the Isle of Man Tramways and Electric Power Company to recover damages for injuries sustained while travelling as a passenger on the company's electric car system, was stated to be settled. It is understood that plaintiff is to receive £250 and costs.

Brayton Oil Engine Company, Limited.—Consequent upon the decision of Mr. Justice Chitty in Brandon *v.* The Brayton Oil Engine Company, Limited, notice is now filed in the *London Gazette* that debenture holders in the Brayton Oil Engine Company are, on or before March 16th, to send by post to Messrs. G. S. & H. Brandon, 15, Essex Street, Strand, W.C. (solicitors for the plaintiff), their names and addresses, &c., along with particulars of the debentures held by them, and the amounts claimed for principal and interest, or they will be excluded from the benefit of the order. Mr. Justice Chitty will adjudicate upon the claims at the Royal Courts of Justice on March 26th.

Business Announcement.—We understand that the practice as Patent Agents, and the business as Consulting Engineers, which have been carried on for the last seven years by Mr. John C. Fell, Wh. Sc., M.I.M.E., and Mr. Reginald W. James, M.I.M.E., A.M.I.C.E., under the titles of Fell & Wilding and Fell & James respectively, will henceforth be carried on under the one style of Fell & James, Consulting Engineers and Chartered Patent Agents.

Bankruptcy Proceedings.—A receiving order was made at Halifax on February 11th on debtor's own petition in the case of Chas. F. Fox, electrical engineer and contractor, "formerly tobacconist," of High Street and Bond Street, Halifax. The first meeting is to be held at the Town Hall Chambers, Halifax, on February 24th, and the public examination at County Court House, Prescott Street, Halifax, on March 9th.

Dissolution of Partnership.—Messrs. J. F. Jennens and J. F. Jennens, jun., lately trading as John Jennens, at Caroline Street, Birmingham, as brass workers, have dissolved partnership by mutual consent. The business will be continued under the old style by J. F. Jennens, who will attend to debts.

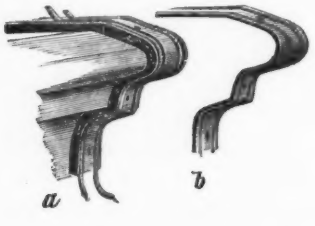
Liquidation Notices.—At meetings held at 18, Wallbrook, on January 13th and February 12th, the members of the Electric Novelty Syndicate, Limited, decided to wind up voluntarily, Mr. G. F. Haskins, of 18, Walbrook, E.C., being appointed liquidator.

Catalogues.—Messrs. H. M. Salmony & Co. have issued an 1896 catalogue of electrical supplies and wireman's sundries. Switchboards, main switches, charge and discharge switches for accumulators, cut-outs, branch switches, ceiling roses, lamp-holders, electric light casings, cables and wires, wireman's tools, ammeters, voltmeters and testing instruments, incandescent lamps of various patterns, sockets, arc lamps, carbon brushes, "Gramme" dynamos

ard motors, transportable motor, tachometers, electric bells, pushes, telephones, dry batteries, accumulators, and a variety of other electrical manufactures, including influence machines, electro-medical coils, &c., &c., are given. The book is very neatly arranged, nicely illustrated, and cleanly printed. We understand that in consequence of the great demand for their instruments and accessories, Messrs. Salmony have been compelled to transfer the manufacture of accessories to separate works at Cheapside, Birmingham, where they have laid down plant of an extensive character. They are also manufacturing, in Birmingham, electroliers and all kinds of fittings, which will be exhibited at their new Show Rooms, at 36, Gerrard Street, specially acquired for this purpose, and which will be ready in a few days.

From Messrs. P. R. Jackson & Co., Limited, of Manchester, we have received a copy of a new catalogue (Section A) and price list. Views are given of the offices, the canal wharf, and scrap yard, heavy machine shop, light ditto, portion of yard, erecting shop, foundry, dynamo, and instrument shops, pattern shops, groups of piston rings, and a number of other photographs and general illustrations. The section before us deals chiefly with the various wheels, racks, pulleys and castings, as manufactured at the Salford Rolling Mills. But shortly other sections will be issued for the piston ring and electrical departments. Messrs. Jackson are, we understand, very busy in all the departments of their works, all the shops working overtime. They have been particularly successful in the new electrical department, and have on order, in addition to a large number of dynamos for electric lighting, and the transmission of power in mines and mills, eight large dynamos of 270 kilowatts each.

Casings.—We illustrate below a new pliable casing for crossing curved surfaces or moulds, manufactured by Messrs. E. J. Dugdill & Co., of Failsworth, near Manchester. The casing



is intended for filling in curved spaces between straight runs of ordinary casing; *a* is the casing showing the wires, *b* representing the cover ready for screwing down. It is claimed that much labour and time is saved, and work of a much neater appearance is ensured by the use of this new casing.

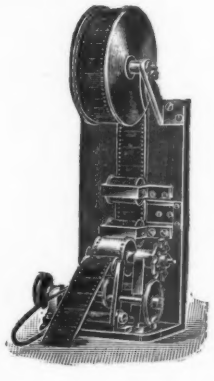
Hungarian National Exhibition, Budapest, 1896.—Information has been received by the Department of Science and Art, through the Foreign Office, from the Austro-Hungarian Ambassador at the Court of St. James's, announcing that a National Exhibition will be held at Budapest this year, which will be coincident with the 1,000th Anniversary of Hungary. The exhibition will be opened on 2nd May next, and we are informed will be of considerable interest to foreign countries.

Lamina Accumulator (Elieson's British Patents) Sydicate (Limited) v. Mackie.—In this case which came before the Recorder on 14th inst. in the Lord Mayor's Court, Mr. S. Smith (instructed by Mr. A. Slater) was counsel for the plaintiff, and Mr. Lewis Glyn (instructed by Mr. Oddy) for the defendant. Mr. Glyn said it had been agreed that the record should be withdrawn on the terms that the plaintiff's solicitor should take the money out of court, the defendant should pay £7 10s. in addition, and each party should pay his own costs. Judgment was accordingly entered upon the terms agreed.

Personal.—Mr. J. D. F. Andrews severed his connection on February 1st last with the firm hitherto carried on under his name, J. D. F. Andrews & Co., at 34, Victoria Street, and has started in business on his own account under the same name, J. D. F. Andrews and Co., and has taken premises by Putney Bridge Station, London, S.W. Mr. J. D. F. Andrews has made some very interesting and important improvements in his system of concentric wiring. The improvements relate more particularly to a new wire which he has specially devised for the system, for the manufacture of which he is setting up plant at Putney Bridge Station. The new wire is claimed to be exceedingly neat in appearance, and sufficiently stiff to be fixed to a wall in perfectly straight lines. The outer conductor is a copper tube, and the insulation is fire resisting.

Some Provincial Work.—Messrs. W. Liley & Co., of Liverpool, have sent us particulars of some recent installation work carried out by them. In the Liverpool district they have fitted up the premises of Messrs. Chaloner & Co., Messrs. Travers & Sons, the Royal Bazaar in Elliot and Bold Streets, and extensions at the Lyceum, and for a number of private firms. They have also supplied a complete installation to the steam trawler, *Mermaid*, comprising engine, dynamo and incandescent lighting, for the owners; complete plant, comprising engine, dynamo, and search light for the s.s. *Paranese*, for the owners; also three complete plants for the Woodside Ferry, Birkenhead, consisting of engines, dynamos, switchboards, &c., and a complete telephone system. They are at present engaged wiring and fitting the residence of Mr. G. B. Newton, in Gamber Terrace, Liverpool. For the Liverpool Corporation a complete system of electric bells is being supplied at the Cornwallis Street and Borough Gardens Baths; for the Corporation new Fever Hospital a system of telephones (magneto generators) and alarm bells. At Manchester they are supplying among others an arc and incandescent contract for Mr. J. Greenbaum, of Deansgate; at Belfast, an arc and incandescent contract for Messrs. Chaloner & Co.; at Sheffield, an electric light and bell installation for Mr. Gray's new house in Clarkehouse Road; and at Dublin, an arc and incandscent installation, including gas engine and dynamo, is being put in for Messrs. Kapp & Peterson, of Grafton Street.

The Theatrograph.—Mr. Robert W. Paul is introducing this apparatus which enables the possessor of any limelight or electric lantern to project on a screen, in view of any number of spectators, any subject containing moving figures, which are represented in their natural motions. The apparatus takes any kinetoscope film. The apparatus is constructed of steel, gun metal, and aluminium, and of such size as to go between the condenser and objective of an ordinary lantern. The film containing the instantaneous photographs is drawn from the spool at the top of the instrument, and passes under the rollers and presser-pad in front of the oblong aperture through which



the light shines, then under an aluminium sprocket-wheel to a second spool, on which it is automatically wound up. Each turn of the horizontal shaft, which is driven from a small hand-wheel, actuates a cam which instantaneously shuts off the light, and at the same time the sprocket-wheel is acted on by a steel finger, causing it to move forward the space of one picture; the film is then locked in position for projection; the shutter opens and allows the picture to be projected. In this way the film is at rest the greater part of a revolution, giving a bright image. The rapid revolution of the shaft causes successive pictures to appear without discontinuity, as in the kinetoscope, until the whole scene has been presented.

ELECTRIC LIGHTING NOTES.

Bath.—Alderman Sturges, in moving the adoption of the report from the Electric Lighting Committee, said the company entertained very much larger views than they (the committee) did of the value of their works, and had offered to sell the whole for £45,000. The committee had considered, however, that this sum was a much larger one than ought to be asked. The company put before them several proposals, but the committee, after meeting several times and going carefully into the different offers, could not, in the light of Mr. Hammond's report, see their way to accept any or either of the proposals. This report was adopted by the council.

Belfast.—Applications for current are coming in from districts a great distance from the central station so that the Electric Committee has to decline them. The committee has expressed the hope that within reasonable time the Corporation would establish a large generating station which would be capable of supplying the entire needs of the city.

Broadstairs and St. Peter's.—Another proposal has been made to the District Council by an electrician who offers to advise. The Council has replied that it cannot entertain the proposal.

Bristol.—The ratepayers of Stokes Croft and North Street in meeting, a few days ago, decided to urge upon the Corporation Lighting Committee that the time had arrived when the public lighting of these thoroughfares by electricity should be taken in hand.

Bray.—The resident engineer reports that new machinery is required for the electric supply works immediately owing to increased business. Before ordering, the Town Clerk is to communicate with an expert.

The Commissioners have signed the deeds for completing the purchase of the electric light works from the liquidator of Messrs. Gordon & Co. for £3,060.

Coatbridge.—The Town Council is to consider the advisability of acquiring the undertakings of the gas and electric lighting companies.

Dudley.—On Saturday last, on the occasion of an employés supper, given by Messrs. Grainger & Smith, of Dudley, on the occasion of their entering on the new premises recently erected, the premises were temporarily lighted by Messrs. Theedham and Whittaker, electricians, of Dudley, the wiring being executed in the short space of 24 hours. The dynamo, which was built by Messrs. Webster, Michelson & Co., of Dudley, was run for upwards of six hours to suit this occasion to double its normal capacity without overheating or detriment to it.

Dundee.—The Lochee Baths and Library are now lighted electrically. A dynamo is driven from the laundry engine. In the swimming baths there are three 1,000 C.P. arc lamps. A number of arc lamps of similar power, and 16 C.P. incandescents, are distributed throughout the various rooms. Messrs. James Maxwell & Son carried out the work.

Ealing.—The Council decided last week to have a profit and loss account for the last four quarters' electric lighting work prepared.

Fareham.—The electric light question at Fareham is now near a settlement, the Local Government Board having announced that they will be prepared to sanction a loan of £6,681 for a period of 20 years, to defray the cost of the various items connected with the purchase of the undertaking, and the laying down of other plant and legal expenses.

Felixstowe and Walton.—The Gas Company does not altogether please the District Council, and a committee is inquiring *re* electric lighting.

Fort William.—The ceremony of cutting the first sod of the lade which is to supply the water for generating electricity to light the burgh of Fort William was performed on 11th inst.

Glasgow.—With reference to the Note in our last issue, giving the result of the visit of Glasgow councillors to Edinburgh, Prof. Alex. B. W. Kennedy points out an error. In the small table we stated that the arc lighting in Glasgow is low tension and in Edinburgh high tension. It should be the other way round. All the Glasgow arc work is high tension (ordinary Brush-series system), while nearly all the Edinburgh arc lighting is low tension, the lamps being worked four in series off the outer mains at 230 volts. About one-fifth only of the Edinburgh lamps are worked through Ferranti rectifiers; the lighting in Princes Street, &c., is all low tension.

Halifax.—The new vertical compound condensing engine supplied by Messrs. Pollit & Wigzell at a cost of £3,000 was started at the Halifax Electricity Works last week. There is some talk in the local press of considering the question of utilising the Corporation water courses for cheapening the cost of the electric light.

Among various improvements in contemplation for the Halifax Parish Church is the introduction of the electric light.

Hanley.—The Traders' Association, the other day, discussed the new charges for electricity, and afterwards interviewed Mr. Lobley, the borough engineer, and laid their objections before him, when he explained his proposals fully, apparently, to their satisfaction.

Harwich.—A Committee has considered the tender of the Town and Village Electric Lighting Company for the supply of an electric lighting installation for the town, but owing to the company having withdrawn their offer to purchase the Corporation's provisional order, the negotiations have been brought to a termination by the Council.

Heysham.—The ratepayers of the Sandylands district have been considering the lighting question.

Leeds.—The Corporation electric lighting plant, which was sold by auction recently by Messrs. Hepper & Sons, is stated to have realised nearly £1,700.

Llandrindod Wells.—We recently stated that the District Council had placed the contract for electric lighting with Messrs. Jevons & Thomas, of Birmingham, the terms of the contract being stated in the Electrical Review for January 24th and 31st. Since this acceptance Mr. Edward Davies, J.P., of Llandinam, has informed the Council that he is prepared to form a company to provide the installation, and will undertake to light the public lamps (32 C.P.) at 40s. each per annum, against 58s. 6d. under Messrs. Jevon's contract, and private lights at 6d. per unit against 7d. and 8d. under the contract. After a heated debate, the Council last Friday resolved to inform the contractors with whom negotiations had been going on (Messrs. Jevons & Thomas) that they were not now prepared to proceed with the proposed contract. Although the standing orders prevented any definite decision being arrived at as to the alternative scheme, it was agreed that Mr. Edward Davies's order should be accepted at the next meeting, and Mr. Davies subsequently attended the meeting and arranged for the immediate completion of the business, so that the street lighting may be installed by next August. It would seem that the question was not sufficiently investigated before the contract was given out. Anyhow, the least that can be said is that the Council's action was precipitate, which is a great pity, for it is anything but businesslike or fair to place a contract upon agreed terms, and cancel it a few weeks later because a more favourable one comes to hand after (as we suppose is the case in this instance) arrangements have been made for pushing forward with the work.

London County Council.—The Council has sanctioned an expenditure of £120 for the wiring of No. 15, Spring Gardens, in the occupancy of the Council. Sanction was given to the County of London Company to construct two transformer chambers in St. John Street Road and Pear Tree Court; and to St. Pancras Vestry to lay mains across Camden Road, in Gray's Inn Road, and in Judd Street.

Maidstone.—The decision of the Council *re* the proposal to hand over the electric lighting order to Mr. King has been deferred for a few days, and in the mean time a public meeting is to be called, and the matter laid before the ratepayers, so as to ascertain their feelings regarding it.

Manchester.—The electric light has been taken up in Manchester far more generally than was anticipated at the time the station was projected. The plant originally fixed comprised six 100 H.P. engines and four of 400 H.P., and it was anticipated that this plant would suffice for three years. At the end of the first year, however, it was found necessary to add two 400 H.P. engines and dynamos. Before two years had passed, it was seen that the demand was growing at such a rate that large extensions would be necessary immediately. The Electric Lighting Committee therefore decided to at once order plant sufficient to fill up the engine room, which had originally been built to admit of large extensions, and to extend the boiler house. Under this scheme eight additional engines of 400 H.P., each with its corresponding dynamo were ordered, and five of these are now erected, while the remainder are being delivered as rapidly as possible. The boiler house, which originally contained six Lancashire boilers and space for a seventh, which latter was supplied when the first extension was made, is being added to so as to accommodate the five new boilers which are now all delivered and on their seatings. A second economiser house is also in course of construction. The whole of the extensions to the generating station will probably be completed by the beginning of the summer, and there will then be over 6,000 H.P. available. In spite of the promptitude of the committee in ordering these large extensions, the present winter has been a most trying one, every scrap of plant being run on the heavy shift, and at times with an overload of 500 H.P. on the station. Nevertheless, there has not been the slightest breakdown or failure of the light. Not only has the demand on the mains originally laid down been abnormally great, but the Committee were most strongly pressed to extend the mains to certain important thoroughfares, notably Oxford Street and the Stretford Road, and accordingly at the time the new plant was ordered, the committee decided to lay down the additional mains for these streets, and also in Swan Street, Shude Hill and Withy Grove Streets, which surround the market, and in which a large amount of business is done. The Oxford Street extension is rather over a mile and a quarter long, and the Stretford Road, which branches from Oxford Street, just over a mile. The mains have been laid entirely by the Corporation staff, and the system adopted has been insulated cables drawn into pipes for feeders, and bare copper strip for the distributors, wherever sufficient space existed. It will doubtless be remembered that the mains originally put down consisted very largely of bare copper, and these have been found to give the utmost satisfaction in every way, there never having been a single fault on them. The advantages of bare copper are exceedingly great; not only is the cost of construction less than with cables, but the durability promises to be indefinitely long, and the ease and cheapness of connecting consumers is most marked when compared with any continuously insulated system. It may be worth while to remark here in passing upon the superiority, in some respects, of bare copper distributors over concentric cables, for with the former, connections can be made with perfect ease to a main through which current is passing, whereas, with concentric cables, this is absolutely impossible. So great is this drawback, that, in the writer's judgment, it practically prohibits the use of concentric cables for distributors, for in Manchester every connection is made on live conductors, experience showing that interruptions of the supply from any cause whatever is calculated to effect infinite harm to the progress of electric lighting. The extensions to the mains have necessitated the construction of two underground chambers for containing transformers for balancing purposes. These chambers, which are situated one near All Saints Church, and the other at Ardwick Green (to which point a further extension of mains, not mentioned above, is being made), are constructed under the footway, and are well lighted by deck-lights, and will be thoroughly ventilated by means of small fans. Another addition to the plant of an interesting nature may here be referred to, viz., a large secondary battery erected about a mile from the station. This battery is approaching completion, and will have a capacity of 600 amperes for two and a half hours, at a pressure of 400 volts. When this discharge has taken place, the voltage of each cell will only have dropped to 1·92 volts, so that there is an ample reserve of capacity, and the prospects of durability should be great. The switching arrangements, which have required a considerable amount of working out, admit of the battery being charged with all cells in series, while it can be discharged so as to feed into the five-wire network, and the pressure between any pair of mains can be adjusted independently of the other three pairs; at the same time it is possible to charge any section of the battery by itself, and also to place any of the four sections of the battery between any pair of mains. It may be of interest to give a few figures as to the present state of the undertaking. Reckoning all consuming devices in 8 candle-lamps, there are now connected up to date 98,995 lamps. The actual connections include 723 arc lamps and 39 motors, though these latter at present only aggregate 38 H.P. There is reason to believe, however, that the use of motors will extend considerably in the near future. The consumers now number 1,089, and there are about 100¾ miles of single conductor laid down in the streets. It should be stated that at present there is no public lighting whatever. The charge made to consumers varies from 6d. per unit as a maximum,

down to 2½d., many consumers obtaining current at the rate of 3d. per unit. The reduction takes place on long hours of consumption, irrespective of the time of day that the consumption takes place, of the nature of the demand, and of the total quantity consumed. The whole of the extensions to plant and mains have been designed by, and the execution of the work carried out, under the personal supervision of Mr. C. H. Wordingham, the Corporation's chief engineer, who, besides acting as resident engineer, has advised them in all matters since July, 1894. Electric lighting in Manchester is fortunate in having an Electric Light Committee who have decided on such a vigorous policy of extension, and it owes much to the ability and untiring energy of the chairman of that committee, Mr. Alderman Higginbottom, while the action of the Gas Committee, under the able chairmanship of Mr. Alderman Gibson, in retaining the electric light as a sub-committee of itself, has had the effect of substituting a friendly rivalry for that snuffing out policy which unfortunately obtains in more than one town.

Margate.—Mr. J. W. Simpson, electrician, of Broad Street, has just lighted his shop and premises by electricity, the dynamo being a "Dudley" type by Messrs Webster, Michelson & Co., of Dudley.

Morecambe.—A public meeting is to be held to consider the agreement between the Council and the Electric Lighting Company.

Plymouth.—Experiments were made last week on tramcars belonging to the Corporation and the Plymouth, Stonehouse and Devonport Tramways Company with electricity as an illuminant, instead of oil. The experiments were undertaken by the I.E.S. Accumulator Company, Limited. Two lamps were placed at each end of the car.

Portsmouth.—Goldsmith Avenue is to be lighted with 28 incandescent lamps, at a cost of £1,500.

Prestwich.—The Sub-Committee which has reported *re* electric lighting thinks that an expenditure of £15,000 would provide for 6,000 lights, but they recommend that the residents be canvassed to see whether that number is likely to be wanted, and this is to be done.

Southampton.—The Electric Lighting Committee, and the Electric Light and Power Company, Limited, have not yet come to any agreement regarding the proposed purchase of the undertaking.

Torquay.—The Council, on Friday, resolved to apply to the Local Government Board for sanction to borrow £22,300 for the electric lighting of the borough, Nos. 11, 12, and 13, Beacon Quay Cellars, or such portions as might be necessary, being used as a central station.

Mr. Trentham, who has reported to the Council, estimates the cost of plant for 4,000 16-C.P. lamps and 70 arc lamps, with the proper reserve power, as follows:—Three boilers, £2,031; six engines, &c., £3,815; dynamos, exciters, accumulators, &c., £4,320; 70 arc lamps and posts, £1,260; mains, transformers, and street work, £5,197; chimney, converting buildings, &c., £1,300; and other items, bringing up the total to £23,716. He recommends 6d. per unit to be charged, and favours dust destructors.

Whitehaven.—Dr. Hopkinson is, we understand, to visit Whitehaven for the purpose of inspecting and reporting upon the present condition and future maintenance of the conductors, and the electric lighting work generally. His visit is to be delayed until Messrs. Siemens have completed the cable which they are preparing as a substitute for a faulty section.

West Ham.—The negotiations between the Council and Prof. Robinson regarding the proposal to appoint him consulting engineer for carrying out an electric lighting installation for the borough, seem likely to come to naught. The question as to whether the electric lighting scheme shall be further proceeded with, is to be discussed at the next Council meeting.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Blackburn and Electric Tramways.—Mr. E. M. Lacey, writing from the Borough Electricity Department, Blackburn, states:—"In your issue of the 14th inst., the proposed traction scheme for the Blackburn Tramways is referred to, and it is stated that the shareholders voted against adopting electricity as a motive power. This gives an incorrect expression of the facts, as not only did the shareholders not vote definitely against the scheme, but the directors of the tramway company are even now carrying on negotiations with the Corporation for the carrying out of the scheme."

Bolton Proposed Tramways.—The recent visit of a deputation from the Bolton Council Committees to Bristol, Coventry and Walsall, for the purpose of inspecting the electric tramway systems, is made the subject of a special article in the *Bolton Weekly Journal*, and a pamphlet is being issued giving a reprint of this article along with illustrations showing the single and double trolley standards used at Bristol.

Bristol Tramway Extensions.—The Sanitary Committee recommends the Council to consent to the application of the Bristol Tramways and Carriage Company for a provisional order to extend the existing, and construct new, electric tramways in certain districts, but they recommend the Council not to consent to a general power being conferred upon the company to work the whole of their tramways by the overhead trolley system or any other system of electric traction involving the laying of electric wires over or under the streets, or to erect power stations within the city, until further consideration shall have been given to the subject upon a definite proposal by the company for so working the whole of their tramways within the city. There are a number of other recommendations. The Electrical Committee recommend the Council not to object to the company being allowed to use electric traction on the tramway to Fishponds Road, and supplying the current from their present station at St. George, on condition that any future proposal for the adoption of electric traction in other parts of the city must be on the principle of the current being supplied by the Corporation. The Committee are of opinion that having regard to the large outlay of capital undertaken by the Corporation to enable them to supply electricity for all purposes, and to the fact that they are prepared to undertake such supply, all future applications for extension of electric traction within the city should only be entertained upon the condition that the electricity be supplied by the Corporation.

Dublin Electric Tramways.—The Pembroke Township Commissioners have unanimously given their consent to the tramways promoted by the Dublin Southern District Tramways Company in the township.

Electric Traction in France.—Permission has been secured to convert the tramways at Lyons into electric lines. The work has to be completed within two years.

Swansea Tramway Scheme.—The Tramway portion of the triple-headed scheme, about which there has been such a stir at Swansea, is stated to be dropped, the negotiations between the Corporation and the tramway company for the purchase having fallen through.

The London County Council and Electric Traction.—The London County Council still stands blocking the way of electric traction. On Tuesday last the Parliamentary Committee reported that by the London United Tramway's provisional order it was sought to exempt the company from the provisions of the London Overhead Wires Act, 1891, and the bye-laws made under the Act, and to authorise the company, with the consent of the Council, to place overhead wires for working the tramways by electrical or other mechanical power, including the overhead trolley system of electric traction or any other system. The Council twice last year refused its consent to the use by this company of electric traction by means of overhead wires, and, having been informed by the Highways Committee that in their opinion the granting of the order should be opposed, they recommended that the Council do refuse its consent to a provisional order being granted to the London United Tramways Company. Earl Russell and Mr. Thompson opposed, and thought the matter should be referred back to be considered on its merits. For the amendment there were only 15 votes, and the original recommendation was agreed to by a large majority.

Visit to Havre Tramways.—The Lord Mayor of Belfast, accompanied by several members of the municipality and the municipal engineer visited Havre on Wednesday, and examined the working of the electric tramways there. M. Papeteray, manager of the Electric Tramway Company conducted the party over the power station, the car depôts, and the various tracks.

TELEGRAPH AND TELEPHONE NOTES.

French Cable Schemes.—The proposed scheme for the establishment of submarine cables between Tamatave, in Madagascar, and the Islands of Reunion and Mauritius, and also of a landline between Majunga and Tamatave, which was referred to the Budget Committee has been reported on unfavourably. It may be interesting to mention some of the estimates of cost on which this unfavourable report was based. Between Tamatave and Reunion some 460 miles of cable would be required, and between Reunion and Mauritius about 140 miles, or a total of 600 miles. The cost of manufacturing this is put at £61,900, or laid and complete with stations, instruments, &c., £104,000. A repairing ship would involve an expenditure of £20,000 in alterations and additional machinery and gear, assuming that the Government would furnish an old gun-boat suitable for the work. The land line across Madagascar is put at £16,600. The total outlay would therefore be £140,700. The annual cost of working, maintenance, &c., is estimated at £20,200, including repairs. Against this there would be traffic receipts and a possible subsidy of £3,000 from the Island of Reunion, but from a commercial point of view it is not considered that the outlay would be justified. Inasmuch, however, as such a scheme, when carried out, places Reunion in communication with the rest of the world, and also provides a duplicate route to Madagascar, its promoters are advised to address themselves direct to the Government, who, it is thought, may consider the scheme worth undertaking.

Manchester Telephones.—There is a correspondence going on in the columns of the *Manchester Guardian* regarding "Municipal Telephones for Manchester."

(*Continued on page* 244.)

THE MOORE "ETHERIC" LIGHT.

WE described in the ELECTRICAL REVIEW, December 27th, 1895, Moore's method of producing electric light by an interrupted electric discharge in vacuum tubes, the principal novelty in which consisted in placing his contact breaker in a vacuum tube, so as to obtain an ether gap instead of the usual air gap on breaking circuit.

At the time we remarked that the "ether gap" was an extremely ingenious idea, but expressed some doubt as to whether a light of practically useful intensity could, under any circumstances, be obtained from phosphorescence of a vacuum tube. We have just received a photograph, taken by Mr. Moore by means of his new lamp, which shows that the photometrical results he has already obtained are considerably in advance of anything hitherto attained by this kind of illumination. The photograph, which we reproduce, was taken in a room 10 by 11 feet in area, with the tubes disposed around the walls, four tubes being used, 9½ feet long by 1⅛ inch in diameter. The number of vibrations employed were 100 per second, and the time of exposure was three minutes. This result, though still far behind sunlight, is a great advance on a photograph (which we copy from the *Century Magazine*), obtained with the Tesla lamp with a 10 minutes' exposure.

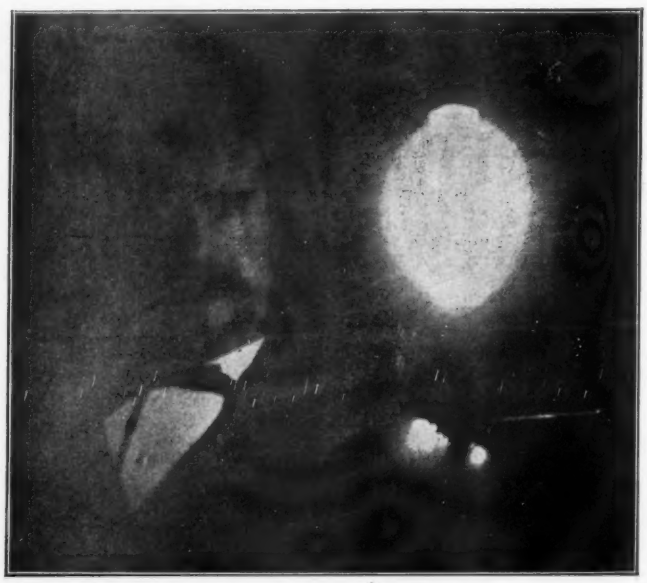
PHOTOGRAPH OF MR. MOORE TAKEN BY ETHERIC LIGHT. EXPOSURE THREE MINUTES.

RECENT PROGRESS IN THE NEW PHOTOGRAPHY.

PROF. RÖNTGEN'S discovery, quite apart from its practical value, has given a great stimulus to investigation in molecular physics. The subject has been eagerly taken up in the

laboratories of the New World as the old; already important results have accrued, and the number of unsolved riddles connected with the question gives promise that our knowledge of the constitution of matter, and the nature of the different forms of energy, will be considerably increased before the solution is arrived at.

Mr. Swinton gave the first public exhibition of the new photography before the Royal Photographic Society on the 11th inst. The lecture was a model of popular exposition, and the experiments highly successful. Mr. Swinton showed the gradual change in the appearance of the electrical discharge as the rarefaction of the air was increased in a tube by an ordinary air pump, the brilliant phosphorescent effects obtained with the higher vacua in the Geissler tubes, and the peculiar properties of the cathode discharge in the extreme vacua of the Crookes tubes. The Crookes tubes used to produce the Röntgen photographs were excited by a 6-inch spark induction coil, and were fixed with their phosphorescent end about 8 inches above the photographic plate. The plate was enclosed in two envelopes of black paper, and laid on the table with its sensitive side uppermost under the Crookes tube. Upon the envelope was placed the purse, hand, &c., to be photographed, and the tube was then excited for three to four minutes. Several very successful photographs of articles handed by the audience were produced. Mr. Swinton exhibited a photograph showing the bony skeleton of a foot which had been produced by an exposure of 55 seconds, probably the shortest exposure yet on record. The powerful discharges necessary for short exposures involve, however, great risk of breakage to the tubes. To reduce this to a minimum, Mr. Swinton exposes for 15 seconds, then allows the tube to rest for an equal time, and so on. Mr. Swinton considers that the high frequency currents are more vigorous in their photographic action than the unidirectional induction coil discharge, but also more dangerous for the tubes. He showed a Crookes tube, with one disc and one ring electrode, specially adapted to utilise the high frequency electrical discharge.



Moore Etheric Light. Photograph taken with Tesla Lamp.

Shortly after the announcement of Röntgen's discovery, M. Gustave Le Bon stated that he had some time before obtained photographs of unseen objects by a prolonged exposure to the light of an ordinary paraffin lamp. These objects were placed in contact with the sensitive film, and probably, therefore, would reduce the unstable silver salt in the film by chemical affinity or electrolytic action. This view appears to be confirmed by some experiments of G. H. Nievenglowski, who has obtained the same results as M. Le Bon, *without any source of light*. This source of error may also be present in Lord Blythswood's experiments, in which he obtained photographs of invisible metallic discs by means of the brush discharge from his gigantic Wimshurst machine.

Prof. J. J. Thomson, MM. Benoist and Hurmuzescu, and others, have found that the Röntgen rays have a powerful effect in discharging insulated electrified bodies. Prof. Thomson has found that positive and negative charges are dissipated with equal facility, and that the discharge takes place even when the body is completely surrounded with insulating material. He concludes, in fact, that all substances become conductors under the influence of the Röntgen radiation. He also states that this discharging power is the most delicate test known for the presence of Röntgen radiation.

Messrs. Siemens & Halske have successfully used for Röntgen photography an ordinary glow lamp excited by the induction apparatus long used by them for the production of ozone. The peculiarity of this induction apparatus is in the contact breaker, which consists of an ordinary dynamo commutator, rotated by an electromotor at a high speed so as to give up to 600 breaks per second. It has been found that a considerable number of lamps can be excited by one apparatus, and it is considered that it will be one of the most economical methods of producing the X-rays. The exposures with Siemens's arrangement were found to be somewhat shorter than with the induction coil and Crookes tube.

RÖNTGEN RAYS, AND THEIR SOURCE.

By T. H. MURAS.

As it has been suggested that a considerable supply of electrical energy is necessary for the production of the new kind of radiation, a few particulars of some experiments with ordinary apparatus may be interesting. An induction coil was used capable of giving a spark 25 centimetres long, when a current of 11 amperes in the primary circuit is suddenly broken. It has a large spring contact-breaker of ordinary form. It was operated for these experiments by four small Grove cells in series, charged with 300 c.c. nitric acid, and 950 c.c. of sulphuric acid of S.G. 1·135. This battery gives 9½ amperes through the primary circuit when the break is held back, and 2 amperes during the working of the coil, as measured by an instrument in which a small piece of soft iron wire is attracted into a solenoid. The coil and its connections are illustrated in fig. 1. The secondary terminals were connected with a small condenser, a Holtz tube 2·5 cm. in diameter, outside, of glass 2·5 mm. thick, with coatings 5 cm. long; this is shown at the top of fig. 1.

The Crookes tube used is of bulb form, 10½ cm. diameter, having a small disc electrode at the top, and a larger concave one at the bottom. The latter is intended to be the cathode, the concentrated rays from it causing a piece of platinum foil at the centre of the bulb to become red-hot over an area about 4 mm. diameter. Fig. 2 is an ordinary photograph of the tube thus operated by the apparatus described, one minute exposure having been given with a lens working at f/8 aperture, on a rapid isochromatic plate. The concave electrode is the cathode. *In all the following experiments, however, the current was sent through the tube the reverse way, the small disc electrode being made the cathode.* The platinum foil then appears quite black on the cathode side. The glass of the bulb phosphoresces bright green about the electrodes, but not much around the middle portion. In order to get some idea of the E.M.F. used, a blunt brass point was connected with the cathode disc, and a large ball with the anode. When these were placed 1¼ cm. apart

in air, the discharge sometimes passed in the form of strong white sparks between them, and sometimes through the Crookes tube. A coil, capable of producing a rapid stream of strong sparks 4 cm. long, without a secondary condenser, is necessary to work the tube so as to produce the red-hot spot previously referred to. Somewhat less energy than this was used in the experiments described below. Ordinary influence machines will not render the platinum red-hot. The tube has not been perceptibly damaged by many hours work. In fig. 1 it is shown in a horizontal position, as it was used for some experiments.

Fig. 1.—Induction Coil, Condenser, and Crookes Tube.

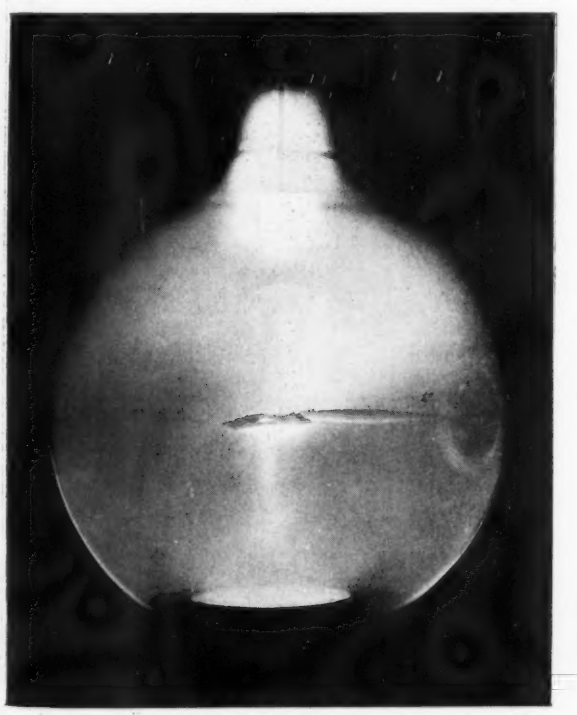


Fig. 2.—Crookes Tube, with Red-hot Spot on Platinum at Centre.

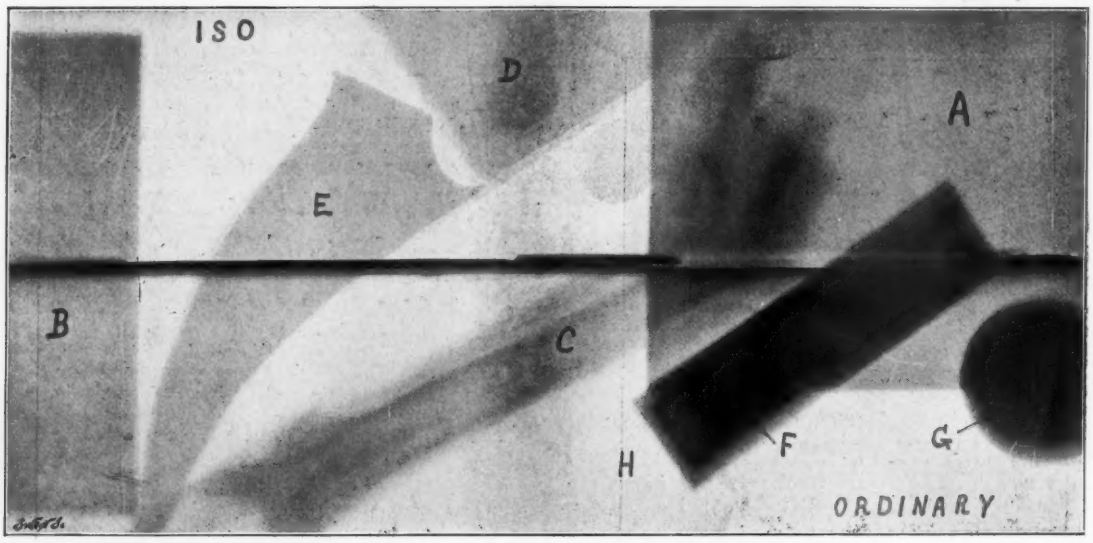
Fig. 3 is a silhouette of two fingers and a watch chain, obtained by 10 minutes' exposure of a Cadett Lightning plate (speed, 226, Hurter and Driffield, but with special development), below two thicknesses of black "silesia"; this fabric being opaque to ordinary light. The side of the bulb was

Fig. 3.—Print from Plate with Short Exposure Below Fingers, and Steel Chain.

Fig. 4.—Print from Plate with Long Exposure Below Hand, a Penny, and a Glass Prism.

20½ cm. from the plate. The negative was developed for 15 minutes, and is thin, but shows what appear to be details

of the bones. The flesh shows well; with longer exposure it tends to disappear, as in fig. 4, which is a print from a plate rapid isochromatic, and covered by an opaque card and two thicknesses of silesia. The shadow is blurred in places,



A, a superposed sensitive plate; B, a strip of glass 1·3 mm. thick; C, part of a chicken's foot and leg; D, mahogany 13 mm. thick; E, ebonite 3½ mm. thick F, lead 1·2 mm. thick; G, halfpenny; H, two extra thicknesses of fabric.

Fig. 5.—Print from Isochromatic and Ordinary Plates, Treated Alike.

Fig. 7.—Photograph of Tube through Small Hole and Opaque Screen.

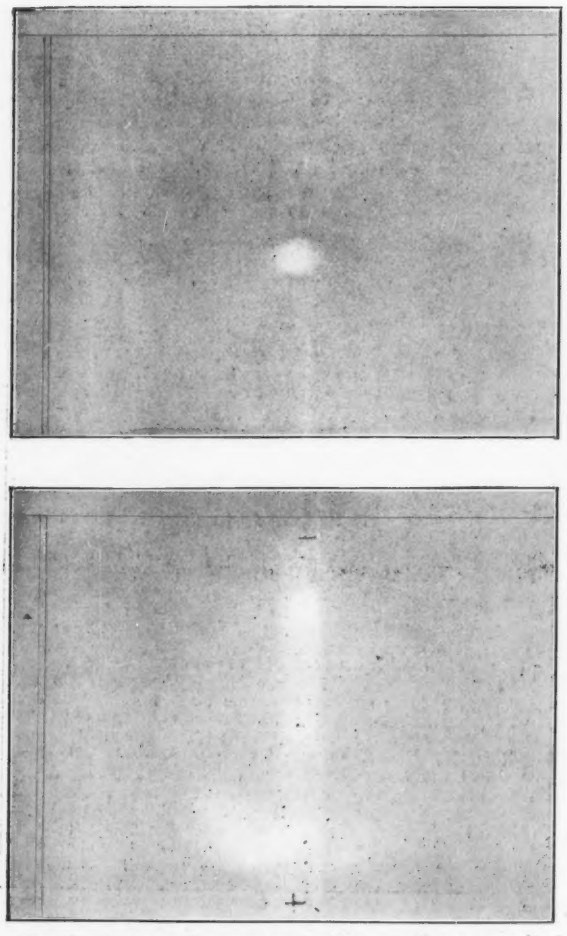


Fig. 6.—Ordinary Photograph of Crookes Tube through Small Hole.

exposed below the hand for 47 minutes, the side of the bulb being only 5½ cm. distant from the plate. The plate was a probably owing to movement of the hand during the long exposure, and to lateral action of light in the sensitive film. The other objects in fig. 4 are a penny and a common glass prism. A similar isochromatic plate exposed in a closed wooden dark slide of a camera, for eight minutes, below the hand, gave only a faint outline

Fig.—8.—Larger Photograph of Crookes Tube through Small Hole and Opaque Screen.

of the fingers and the grain of the wood of the slide. The plate was about 12 cm. from the side of the bulb. As a check experiment, a similar plate in the same slide was held behind the hand in weak sunlight for 18 minutes, and developed for 30 minutes. There was no image on it except marks due to leakage of light at a joint. Another similar

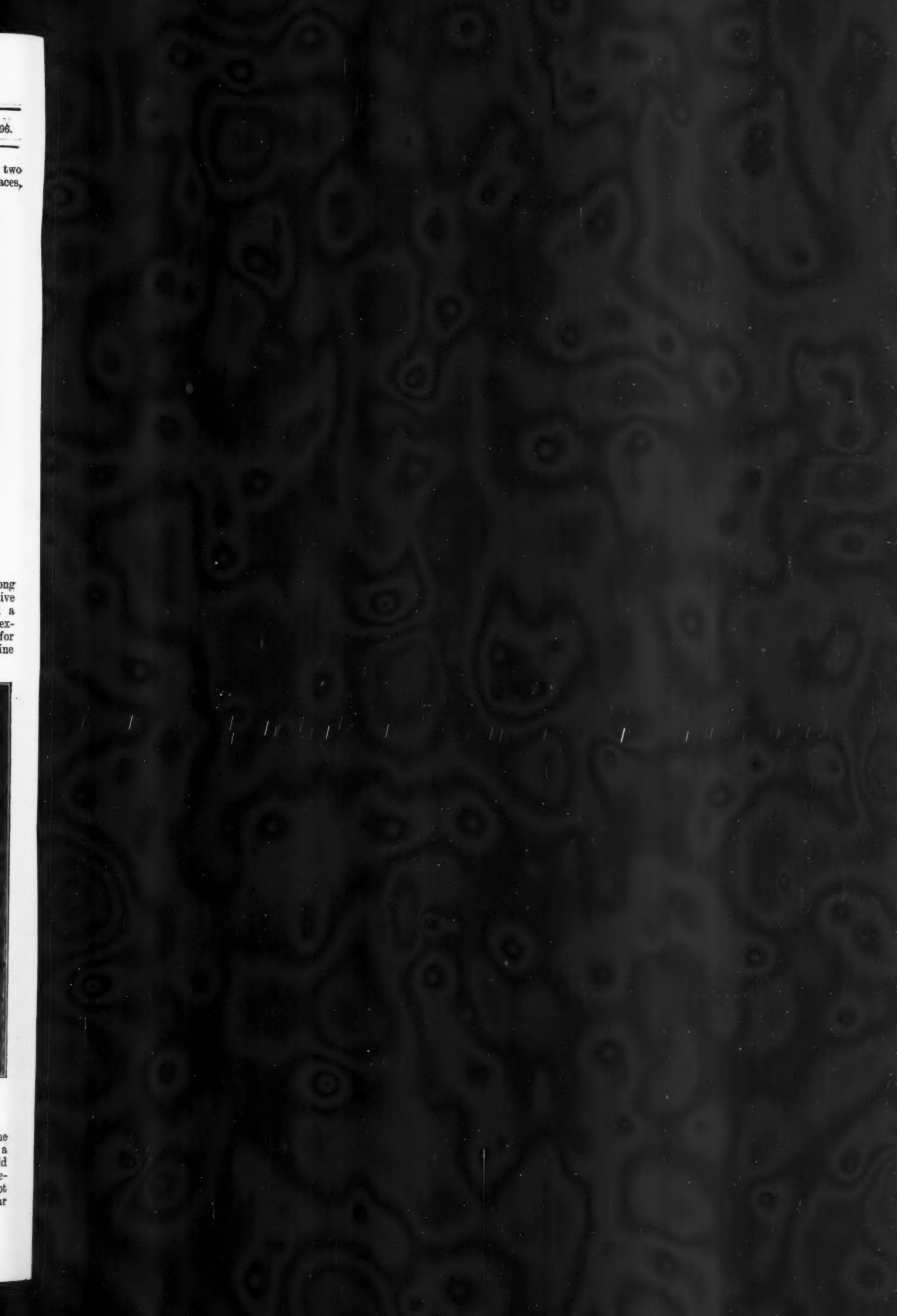


plate was exposed similarly in the closed slide for 15 minutes, 10 cm. below an ordinary vacuum tube containing a phosphorescent powder, excited brightly by an influence machine. It also had received no impression.

To compare effects on isochromatic and ordinary gelatino-bromide plates, strips of rapid isochromatic and ordinary plates, of about equal speeds for ordinary photographic purposes, were exposed, developed, and printed together and similarly in every respect. The plates were covered by an opaque card and two thicknesses of silesia, on which various objects were placed. Exposure 25 minutes, the plates being 5 cm. from the side of the bulb. Fig. 5 is a print, and it will be seen that the strips give identical results. A Swan photo-mechanical plate was placed over one end of the strips, below the card, and had a much fainter impression on it. Two extra thicknesses of the silesia fabric placed at H have produced no perceptible shadow.

In order to ascertain the source of these rays in the Crookes tube used, photographs of the bulb itself (viewed as in fig. 2), have been made by the camera, with the small disc negative as in the preceding experiments. A hole 4·2 mm. diameter in a lead sheet was used in place of a lens. Owing to its size it gave a very fuzzy image, such as would delight the eyes of a "Photographic Salon" photographer, but sufficient to allow determination of the positions of different parts. Fig. 6 is an ordinary photograph, being a print from a negative obtained through the small hole with no screen, giving one minute exposure on a Cadett plate (226 H. and D.). The central light comes from the platinum foil, and the other lights come from the concave electrode (the lower one in the illustration), and the disc. Fig. 7 is a photograph under identical conditions, except that an opaque card and fabric screen was in front of the plate, and exposure for an hour was given. Corresponding position lines are marked on the plates. Nothing remains in the latter photograph except the image of the light from the platinum foil at the middle of the bulb. It thus appears that in this Crookes tube the rays proceed from the central platinum, and not from the electrodes, or the neighbouring brightly phosphorescing glass. Fig. 8 is another photograph of the bulb, on a larger scale, taken through the small hole and opaque screen on a rapid isochromatic plate. The hole was only 4·2 cm. from the side of the bulb, and 6·9 cm. from the plate; 100 minutes' exposure was given. Marks on the plate indicate the height of the electrodes and platinum, as determined by measurements on the focussing screen of the camera. It will be seen that most of the light comes from the foil at the centre, and a little from near the concave electrode, probably from the adjacent glass, unscreened by the central platinum.

ON THE RAYS OF RÖNTGEN.*

By Prof. E. SALVIONI.

I HAVE the pleasure of briefly communicating to the Academy the results of some studies which I have undertaken on the rays of Röntgen.

The theoretical portion of these studies had for its object to examine if Röntgen's agency could be considered as a form of light in the sense that this agent consists in vibrations of the ether. It is known that Röntgen, in his memoir, emphasises the probability that we have to do with longitudinal waves of the ether. Now the totality of the facts established by him, and especially the fact that the agent is propagated with the same rapidity in different transparent media, and that a substance is so much the more transparent to these rays the smaller is its density, have caused a doubt to spring up in my mind that the power may be due to highly subtle matter† projected from the Crookes tube, a matter to which bodies are permeable, so much the more as they are less compact. Bodies will be traversed by the subtle particles of this matter more or less easily as a net more or less close would be by a discharge of small shot. I communicated this idea in private conversation, and have since found that, without my knowledge, it had appeared in a correspondence in a daily paper.

From a very summary account of a lecture delivered at Pisa by Prof. Garbasso, I learned that this idea is shared by him and Battelli, and is confirmed by their researches. But what is the subtle matter? It must either be common matter projected from the Crookes tube or imponderable matter, such as the cosmic ether.

Let us pass to that portion of my studies which renders the application of Röntgen's discovery more easy. I submit to the Academy photographs taken by Röntgen's method.

The photographs of several metals (magnesium, aluminium, iron, lead, zinc, copper, palladium, silver, gold, platinum) confirm the relation between transparency and density discovered by Röntgen.

I give a photograph of my hand showing the bones. The cartilages are not transparent, but the spongy parts of the joints are more transparent. Two of the photographs show a frog paralysed with curare taken with different times of exposure. One of these proofs, besides the bones, shows the two lungs; in the other there are seen, besides the lungs, also the heart and another viscus.

I have then turned my attention to the eye. Röntgen has found that bodies fluorescent by common light fluoresce also in his rays. I instituted experiments on a retina taken from a living animal—a rabbit. The observations made with the living retina showed that the retina is somewhat fluorescent to the light emanating directly from a Crookes tube, but with the Röntgen's rays there was no appearance of fluorescence. I studied in the sequel by the photographic method the transparence of Röntgen's rays in the dioptric apparatus of the eye, and I obtained the result that the totality of the various media which constitute it intercept the rays of Röntgen almost like a small plate of common glass, of the size of one millimetre, and hence very little transparent. It seemed possible to see in an indirect manner through wood, aluminium, flesh, &c., by an indirect method transforming Röntgen's rays into common luminous rays before they arrive at the eye. I have constructed a simple apparatus by means of which I can see distinctly the outline of objects enclosed within boxes of card, aluminium, &c. This *cryptoscope*, which I have the pleasure of submitting to the Academy, is a small tube of cardboard of about 8 centimetres in height. Its bottom is completely closed with black cardboard on which is laid a stratum of fish-glue and calcium sulphide, a substance which I have found very phosphorescent in Röntgen's rays. Within the tube of cardboard at the other extremity to which the eye is applied is fixed a lens which enables us to see clearly the phosphorescent cardboard, keeping the eye in a state of repose. With this cryptoscope applied to the eye, it is possible to see, even in a lighted space, the form and position of metallic bodies enclosed within boxes of cardboard, of wood, of aluminium, and within flesh.

This apparatus, when suitably improved, will be found convenient for surgical and medical applications not less in the scientific study of phenomena substituting direct vision for photography. For calcium sulphide there may be substituted with advantage platinum and barium cyanide.

* A communication made to the Medico-chirurgical Academy of Perugia, on February 6th, 1896.

† Radiant matter.

Trade with China.—We understand that a commercial mission, consisting of seven persons, is to proceed to China shortly for the purpose of inquiring into the present conditions of trade between England and that empire with a view to opening up new fields for British commerce. The Blackburn Chamber of Commerce set the ball rolling, and the necessary expenses of the expedition are being subscribed privately, Mr. Yerburgh, M.P., having undertaken to contribute one-third, if the remainder is forthcoming within six weeks. The progress of this mission should be closely watched by electrical manufacturers at home, for sooner or later a vast field will undoubtedly be opened up in China for electrical work, and one effect of this mission may be to hasten that period.

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 238)

Telegraphic Interruptions and Repairs.—Up to noon on Wednesday the following returns were made:—

	Down.	Repaired.
Brest-St. Pierre (1869 Anglo)	April 6th, 1895.	... ...
" " (P.Q.) ...	June, 1895.	... ...
Brest-Penzance (P.Q.) ...	... ...	... ...
Puerto Plata-Martinique ...	Dec. 19th, 1895.	... ...
Odessa-Constantinople ...	Jan. 17th, 1896.	Feb. 17th, 1896.
Landlines—		
Havana-Batabano	Feb. 12th, 1896.	Feb. 13th, 1896.
" "	Feb. 15th, 1896.	Feb. 16th, 1896.

Berne notifies: February 13th, 1896, communication with Manaos established; intermediate stations not yet opened.

The Hawaii Cable.—The majority of the U.S. Senate Committee on Foreign Relations is stated to be favourable to this cable receiving support of the Government. The sub-committee has reported in favour of an annual subsidy of $160,000 for 20 years, Government business to be transmitted free until the amount transmitted equals the total subsidy. The final decision on the matter was postponed, to permit of an investigation into the claims and resources of the two companies in the field.

The British Pacific Cable.—We publish the following extract from the *New Zealand Herald*. After pointing out the opposition which this project has met with from the cable ring, our contemporary, referring to the Colonial Governments, goes on to say:—"The only way in which they can save themselves from the snare will be by constructing the Pacific cable themselves, and working it themselves, as earnestly urged by Mr. Sandford Fleming from the first. That gentleman has been keenly alive to the danger, and not without reason has he pressed on the Australasian Governments not to have the work undertaken by any company on subsidy or guarantee, for that the company would be sure to be brought over or combined in some way, so as to retain the ascendancy of the old monopoly in the hands of the Eastern Extension Company and Sir John Pender. The way in which Mr. Fleming advises—and no other man has studied the subject as he has, or thrown so much earnestness and perseverance into the work—is that the three parties to it—the Imperial Government, the Canadian Dominion, and the Australasian Colonies—should undertake this cable as a public work in the same way in which one of our colonies builds and works its railways, each of the three contracting parties accepting a third of the total liability. The tenders having been called tentatively by Canada acting for the others, it has been found that they ranged from a little over a million up to two millions and over, but that the total cost on a most liberal scale would not exceed two millions sterling, the interest on which raised by loan, with such a joint guarantee, would not exceed £45,000 a year. Of this £15,000 would be the annual liability for the Australasian colonies—say Victoria, New South Wales, Queensland, and New Zealand. On a population basis, the share of this liability for New Zealand would be between three and four thousand a year; and yet the colonies hang back from an undertaking that is bound, without any chance of error, to return a splendid profit from the first, without the risk of a call on the taxpayers to meet a farthing of interest. The liability is really so small, and the prospective profits so large, and apparently so certain, from the moderation of the figures used in the calculations, that it seems absurd to haggle over the matter with the Imperial Government, which seems so unwilling to commit itself. Further than this, on the joint guarantee of Canada and the four Australasian Colonies alone, the small loan of two millions could be raised quite as easily at three, or probably two and a-half per cent., and the advantage of acting independently of the Imperial Government would be that the colonies could send *all* the traffic by their own cable. There would be nothing either unreasonable or unsual in this, and commanding, as the Governments do, the land lines, the cable would be simply an expansion of the telegraph service. Under such conditions the service would be beyond all dispute a highly lucrative one, and as the Governments would require only to meet the two and a-half or three per cent. interest instead of ten per cent. dividends or more, as expected by the cable companies' combination, they could afford to reduce the tariff of cable service, till in all probability before two or three years had passed we should have cable messages to England at two shillings or possibly a shilling a word. There is, of course, the guarantee by the colonies to the Eastern Extension Cable Combination for a few years yet to run. But suggested provision has been made for the redemption of this in the calculations of Mr. Sandford Fleming, and altogether there is nothing to prevent the Colonial and Canadian Governments, if owning and working the cable, from securing the whole of the cable traffic between the eastern colonies of Australia, New Zealand and England. It seems a surprising thing that in all the calculations made, and all the voluminous negotiations that have passed on the subject, nobody has ever suggested the possibility of *all* the traffic being borne in this way by the trans-Pacific cable. Mr. Fleming's estimates are all based on the supposition that the new cable would obtain half the present traffic with the normal annual increase. And yet on this basis he shows conclusively a substantial profit. But supposing the cable to be owned by the Governments that own the land lines, what obstacle in reason, usage, or common sense, is there in the way of the Governments sending all the traffic on by their own cable? It would be a terrible blow in the face to the Eastern Extension Company, but exactly such a blow as it deserves, for the grinding monopoly it has exercised for so long over the colonies; and New Zealand and Queensland, which have suffered most, should make it a *sine qua non* of their joining in the project, that the work should be constructed and the service conducted by the Governments; and that as a natural sequel every cable message received at the telegraph offices of the several contracting colonies for transmission should be sent on through the Government's cable alone. It is needless to say that if this is done, and all the traffic is secured to the new cable, it will be the most lucrative public work in which this or any other of the colonies ever invested a public loan."

Telephones at Birmingham.—At the Birmingham Workhouse Infirmary, Messrs. Walker Bros. have just completed a telephone system, the switchboard being of special design. Messrs. Walker are responsible for the maintenance of all the electrical apparatus of the Board of Guardians.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—March 1st. The Municipal Authorities of Brünn are inviting tenders for the establishment of a central station in the town for the generation and supply of electrical energy for lighting and power purposes, including that necessary for an electric tramway. Tenders to be sent to the Burgermeisteramt der Landeshauprstadt, Brünn, Austria.

Bangor.—March 18th. The Corporation invites tenders for the construction, supply, and laying down of the necessary plant and mains for the supply of electricity in the Borough. For further particulars see our "Official Notices."

Canary Islands.—February 29th. Tenders are being invited for the 35 years' concession for the electric lighting of Sainte Croix de Teneriffe, Canary Islands. Tenders to be directed to the Ministère de la Gobernacion in Madrid, Spain.

Eston.—May 1st. The District Council invites schemes for lighting the district by electricity, such schemes to embrace (*a*) plan and estimated cost; (*b*) annual working cost and maintenance. Particulars from the District Surveyor, Grangetown, Yorkshire.

France.—February 27th. Tenders are invited by the General Direction of the French Posts and Telegraphs for the supply of 125 tons of copper or bronze wire. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

France.—February 28th. The General Direction of the French Posts and Telegraphs is inviting tenders for a quantity of telephone cable and six lots of material for telephone batteries. Tenders to 103, Rue de Grenelle, Paris.

France.—February 29th. Tenders are being invited for the supply of galvanised iron supports and galvanised iron boxes. Tenders to the Direction, Générale des Postes et des Télegraphes, 103, Rue de Grenelle, Paris.

Germany.—February 28th. Tenders are being invited for the supply of the porcelain insulators and iron and bronze telegraph wire required during the financial year, 1896-97. Tenders to the Königliche Eisenbahn, Direction, Elberfeld.

Germany.—March 18th. The municipal authorities of Herne are inviting tenders for the concession for the construction of a tramway, to be operated either by means of gas motors or electricity, between Herne and Recklinghausen, a distance of about 9 kilometres. Tenders are to be directed to Der Verwaltungsausschuss' Herne, Germany.

Italy.—February 28th. Tenders are being invited by the Municipal Authorities of Parma, an important old town about 60 miles from Milan, for the concession for the electric lighting of the public streets for a period of 15 years, commencing June, 1897.

Keighley.—March 4th. Tenders are invited for providing telephonic communication between the various buildings forming the infectious hospital now in course of erection at Morton Banks, near Keighley, for the Keighley and Bingley Joint Hospital Board. Particulars on application to Mr. Alfred Moore, clerk of the works at the hospital.

Metropolitan Asylums Board.—The Board on Saturday authorised the Brook Hospital Committee to instruct Prof. Kennedy to prepare specification for fitting up a telephone system, and electric bells and fire alarms in the hospital. Advertisements inviting tenders for the work are to be issued.

Sunderland.—March 13th. The Corporation invites tenders for engines, dynamos, boilers, &c., for the electric supply station. Details will be found among our "Official Notices."

Tunbridge Wells.—February 25th. Tenders for the enlargement of the Corporation central electric lighting station have to be sent to the Town Clerk (Mr. C. W. Cripps), at the Town Hall, by Monday next.

CLOSED.

Bradford.—The contract for the boilers, fans, and some other machinery necessary at the new electricity works is to be placed with Messrs. John Brown & Co., Limited, of Sheffield. Estimates of the cost of the extension of the supply along Manningham Lane as far as Queen's Road are to be prepared, with a view to carrying out the work if sufficient applications are made.

London.—The estimate, at £59 7s. 4d., of the Private Wire and Installation Company has been accepted by the Fountain Hospital Committee, of the Metropolitan Asylums Board, to make good the defects in the electric bell system.

Stanton.—The following tenders were sent in to the Swadlincote District Council for work connected with the proposed electric lighting of Stanton. That of Messrs. Hall & Geary was accepted.

Fletcher, Hirst & Co., Burnley	£117
Cutting Bros., Derby	119
Hall & Geary, Church Gresley, Burton-on-Trent (accepted)	120
Electric Construction Company, Wolverhampton	145
Walsall Electrical Company, Walsall	151
Ellis & Ward, Birmingham	179
H. M. Edwards, Wakefield	186

Southport.—Tenders were sent in by the following firms for electric lighting and fittings at Belle Vue, Southport, for Sir George A. Pilkington.

	£	s.	d.
A. Maund, Southport, (accepted)	293	0	0
Verity & Co., Manchester	293	6	0
Manchester Edison-Swan Company	304	11	6
Liverpool Electric Supply Company	340	0	0
C. Hill & Co., Manchester	345	3	0

CITY NOTES.

House-to-House Electric Light Supply Company.

THE recently-issued report of this company records nothing very startling. The revenue from the sale of current has increased, and a number of lamps have been added during the year 1895. The cost of production is slightly more favourable than last year, and the average price obtained per unit is maintained. The directors have adopted the eminently sensible course of reducing the construction business development account. The following are extracts from the directors' report:—

"The revenue account shows a credit balance of £6,840 16s. 1d., which, with the balance of £108 11s. 5d. brought forward from the previous year, and £49 11s. 8d., being dividend on 300 £5 fully paid ordinary shares in the Yorkshire House-to-House Company, Limited, together with £12 10s. 5d. for interest on deposit at bank, makes a total of £7,011 9s. 7d. After deducting £1,907 18s. 4d. for interest on debenture stock paid and accrued, and other interest, and £875 for interim dividend paid on the 7 per cent. cumulative preference shares, the directors recommend that the sum remaining, viz., £4,228 11s. 3d., be dealt with as follows:—

In reduction of preliminary expenses	£500	0	0
To credit of depreciation account	2,000	0	0
To payment of the remainder of dividend to December 31st, 1895, on the 7 per cent. cumulative preference shares	875	0	0
In reduction of the construction business development account	788	11	11
And that the balance of ... ... be carried forward to the next account.	64	19	4
Total	£4,228	11	3

The amount of £829 9s. 4d., received as premiums on the issue of £10,000 debenture stock, it is proposed to apply in further reduction of the construction business development account, thus reducing that item to £15,000. The following Table shows the progress of the company's electric lighting business since 1890:—

Year.	Equivalent of 35-watt lamps connected.	Increase in 35-watt lamps.	No. of houses connected.	Gross revenue.			Expenditure.			Net revenue.		
				£	s.	d.	£	s.	d.	£	s.	d.
1890	13,665	9,145	248	5,010	9	2	4,624	6	5	386	2	9
1891	19,388	5,723	373	8,328	3	11	6,077	14	10	2,250	9	1
1892	23,700	4,312	471	10,688	18	6	7,851	19	6	2,856	19	0
1893	28,429	4,729	599	12,063	10	10	7,832	6	8	4,231	4	2
1894	35,858	7,429	755	13,695	11	8	7,431	16	8	6,263	15	0
1895	44,162	8,304	932	15,394	16	11	8,554	0	10	6,840	16	1

"The increase in the lights connected during 1895 was equivalent to 8,304 8-candle-power (35 watt) lamps, being the largest increase since the year 1890, and the increase in revenue was £1,699 5s. 3d., while the working expenses show an increase of £1,122 4s. 2d. During the year various alterations and additions to the plant have been made, which, it is anticipated, will tend to reduce the cost per unit of electricity in the future; but the effect of carrying out these works, while maintaining continuous running of the plant, has naturally tended to increase the works' cost for the period under review. A sum of £18,532 8s. 9d. has been expended during the year on additional plant, mains, and buildings, and the expenditure for 1896, to meet the increased demand, is estimated at £15,000. In order to provide for this outlay, a further issue of capital is necessary, and a circular containing the terms thereof is enclosed herewith. With regard to the construction business development account, the directors regret that they have been advised that the accounts of the Leeds and London Electrical Engineering Company, Limited (to whom this business has been leased), do not admit of the distribution of any profit. During the year 1895, a further £10,000 of 4½ per cent. mortgage debenture stock has been issued, bringing up the total issue to £50,000, being the full amount created."

	1893.	1894.	1895.
Total capital invested ...	—	£83,847	£101,930
Number of units sold	—	400,911	476,714
Number of lamps connected ...	—	35,858	44,162
Revenue from sale of current...	—	£12,578	£14,390
Net revenue	—	—	£6,841
Average price obtained per unit	—	7·44d.	7·2d.

Cost of production.	£	s.	d.	Per unit.
Coal	3,313	0	0	1·67d.
Oil, waste, water, and engine room stores	630	0	0	·32d.
Salaries and wages at generating station	1,873	0	0	·94d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	554	0	0	(Works' cost 4·21d.) ·28d.
Rates and taxes	509	0	0	·26d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,404	0	0	·71d.
Depreciation of buildings and plant account	2,000	0	0	1·0d.
Renewal fund account	—			—
Total	£10,283	0	0	5·18d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	14,390	0	0	7·2d.
Meter rents	882	0	0	—
Sale of lamps	—			—
Total	£15,280	0	0	7·2d.

Total cost per unit (exclusive of depreciation and renewal accounts), 4·18d.; works' cost, 3·19d.

Kensington Company's Accounts.

THIS Company we are pleased to note continues to make solid progress, and the serious fire which the company experienced some time ago has apparently only acted as a slight check in the operations of the concern. Thanks to the splendid efficiency of the staff, one has always looked upon the Kensington figures among the first of metropolitan electric lighting works. There has been an increase in the number of units sold, somewhere about 240,000, and there is a corresponding decrease in the total cost of production. The works' costs are considerably less than last year, the figure now standing at 1·76d., against 2·11d. for last year. It is interesting to compare the outputs and cost of production with the two principal London Companies that have published their accounts, although we fully recognise the fact that these comparisons take no note of different working conditions.

	Units sold.	Coal	Works' cost.	Total cost.
Westminster Company ...	2,830,396	·57	1·46	2·40
St. James's	1,846,064	·59	1·67	2·68
Kensington & Knightsbridge	1,228,734	·66	1·82	2·43

The following are extracts from the directors report:—

"The mains, which extended to a length of 18¾ miles on December 31st, 1894, have been increased during the year 1895 to 20 miles. During the year the number of houses and shops connected with the system has increased from 908 on December 31st, 1894, to 1,109 on December 31st, 1895; while the number of lamps calculated on the usual basis of 8 candle-power has increased from 80,678 to 94,780. The debenture debt of the company has been converted from 4½ per cent. first mortgage debentures to 4 per cent. debenture stock. The debentures were paid off at £105 by new stock issued to the holders. Further issues of debenture stock have since been made, £6,800 at £103, and £15,755 at £105 per cent., of which amount £11,780 15s. 0d. was paid by December 31st. The directors have thought it advisable to appropriate the balance of premiums thus obtained after deducting the expenses of creation and issue of this stock, to the reduction of the cost of conversion. The directors have written £1,000 off the goodwill account, and strengthened the renewal account by transferring to it £4,270 2s. 11d., making the total amount placed to that account £9,990 13s. 8d. After providing for the above amounts, and paying the dividends on the 6 per cent. first preference shares to June 30th, 1895, on the 5 per cent. second preference shares to September 30th, 1895, and an interim dividend at the rate of 5 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the nett revenue account for the year 1895 is £5,227 7s. 6d. Of the above sum £1,450 0s. 0d. has been appropriated to the payment of the first preference dividend

to the end of the year, and £150 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date, leaving £3,627 7s. 6d., out of which it is proposed to pay a further dividend on the ordinary shares, at the rate of 7 per cent. per annum for the past half-year, making, with the interim dividend paid to June 30th, 6 per cent. for the year. This will leave a balance of £1,089 17s. 6d. No provision has been made in the accounts for directors' remuneration."

The analysis of the company's costs is as follows:—

	1893.	1894.	1895.
Total capital invested ...	£175,927	£187,300	£208,581
Number of units sold	724,308	977,797	1,228,734
Number of lamps connected ...	64,529	80,678	94,780
Revenue from sale of current...	£20,746	£24,738	£28,091
Net revenue	—	£9,289	£10,988
Average price obtained per unit	6·87d.	6·09d.	5·3d.

Cost of Production.	£	s.	d.	Per unit.
Coal	3,490	0	0	·68d.
Oil, waste, water, and engine room stores	686	0	0	·13d.
Salaries and wages at generating station	2,765	0	0	·54d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	2,401	0	0	(Works' cost 1·82d.) ·47d.
Rates and taxes	1,073	0	0	·21d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	2,048	0	0	·40d.
Depreciation of buildings and plant account	1,253	0	0	·25d.
Renewal fund account	4,270	0	0	·83d.
Total	£17,986	0	0	3·51d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	28,091	0	0	5·3d.
Meter rents	920	0	0	—
Sale of lamps	10	0	0	—
Total	£29,021	0	0	5·3d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·43d.; works' cost, 1·82d.

Notting Hill Electric Lighting Company.

THIS Company is progressing favourably. Last year the ordinary shareholders had to content themselves with a small dividend of 2s. on each £10 share. Things have mended so much that this year the directors feel justified in paying two per cent. on the ordinary stock. There is an increase in the output of over 50,000 units, and a decrease in the works cost, despite the fact that a considerable sum has been spent on renewing accumulators. The following are extracts from the directors report:—

"The expenditure on capital account at the date of the last balance sheet, stood at £78,335 16s. 1d. During the past year a further sum of £5,702 18s. has been expended. The largest item is for an additional battery of accumulators, which has been rendered necessary by the expanding business of the company, and the balance is principally for mains in Addison Road and for other extensions. The required capital has been raised by the issue of ordinary preference shares, and owing to an increased demand for these shares, the directors have been able to obtain a premium of £2 a share in recent allotments. The amount of premiums thus obtained, viz., £246, has been applied to the reduction of the preliminary expenses account. The whole of the remaining unissued shares, amounting to £11,380, have been applied for at the same premium, and when allotted the Directors will be enabled to apply the premiums realised (£2,276) to the further reduction of this account. The revenue account shows a profit of £3,227 14s. 10d. as compared with profits of £2,101 17s. 8d. in 1894; £1,481 7s. 1d. in 1893; £112 6s. 1d. in 1892; and a loss of £554 18s. 6d. in 1891. The number of lamps on the circuit has increased from 15,669 to 20,307, being an increase of 4,688 lights, against increases of 3,516 in 1894, 2,715 in 1893, and 3,382 in 1892. The amount received from the sale of current shows an increase of £1,686 12s. 2d. following an increase of £687 4s. last year, and has now reached a total of £5,881 10d. The expenditure on repairs and maintenance has been £780 3s. 3d., an increase of about £270 over last year. This increase arises from special additions which might have been charged against the depreciation reserve; the whole of this amount was, nevertheless, paid out of revenue. The sum of £700 has been set aside for depreciation and renewals, making up this fund to £1,300, and after writing 3 per cent off the preliminary expenses and allowing for the other items on the net revenue account, a balance remains of £2,329 9s. The directors recommend the following dividends:—(1) 6 per cent. less income tax on the ordinary preference shares for the year ending December 31st, 1895, £901 17s. 2d.; (2) 2 per cent. free of income tax on the ordinary shares, £1,290 8s.; carrying forward the balance of £137 3s. 10d.

The following table gives the cost per unit:—

	1894.	1895.	1896.
Total capital invested	—	£78,335	£87,085
Number of units sold	—	130,266	182,327
Number of lamps connected ...	—	15,669	20,307
Revenue from sale of current ...	—	£4,194	£5,881
Net revenue	—	£2,401	£3,228
Average price obtained per unit..	—	7·7d.	7·6d.

Cost of Production.	£	s.	d.	Per unit.
Coal	601	0	0	·79d.
Oil, waste, water, and engine room stores	102	0	0	·13d.
Salaries and wages at generating station	362	0	0	·48d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	780	0	0	(Works' cost 2·43d.) 1·03d.
Rates and taxes	31	0	0	·04d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,347	0	0	1·77d.
Depreciation of buildings and plant account	700	0	0	·92d.
Renewal fund account				
Total	£3,923	0	0	5·16d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	5,881	0	0	7·6d.
Meter rents	322	0	0	—
Sale of lamps	—			—
Total	£6,203	0	0	7·6d.

Total cost per unit (exclusive of depreciation and renewal accounts), 4·24d.; works' cost, 2·43d.

Charing Cross and Strand Electricity Supply.

WE noted last year that, in spite of somewhat heavy coal costs, the total cost of production was very creditable. It is still more marked this year, the total cost per unit standing at 2·16 against 2·5 for 1894. Mr. Patchell's economical results, in spite of high coal figures, are very much to be admired.

The following are extracts from the directors' report:—

"There has been a constant increase in the demand for current; while on December 31st, 1894, the company were supplying energy to 41,216 8-C.P. lamps, they were on December 31st, 1895, supplying to 51,302 8-C.P. lamps, being an increase of nearly 25 per cent. over those supplied in that year, and 48½ per cent. over those supplied in the year 1893. The station has been maintained in a high state of efficiency, but the directors have thought it well to carry £3,000 to depreciation account. The provisional order enabling the Corporation to supply electricity in the district of the Strand District Board of Works was granted by the Board of Trade, and the Bill confirming it passed a Committee of the House of Lords; owing, however, to the dissolution of Parliament, the Bill could not be dealt with by the House of Commons, by whom it will be considered in the present session of Parliament. In view of the large increase in the business of the Corporation, a wharf and spacious premises, covering an area of 29,000 square feet, have been secured in the Commercial Road, Lambeth. The necessary alterations to render the premises suitable for an electric lighting station are now being made, and trunk mains laid connecting up the proposed station with the existing station of the Corporation at Maiden Lane. The net earnings, as shown in the revenue account, have amounted to £12,587 3s. 11d.; £700 has been written off for preliminary expenses; £300 from law costs suspense account; £3,262 10s. has been paid in receipt of interest on debentures up to December 31st, 1895; and £2,899 18s. 10d. was distributed in payment of an interim dividend at the rate of 4 per cent. for the half-year ended June 30th, 1895. A sum of £5,424 15s. 1d. now remains, which, added to the undivided profit of £304 19s. 10d. from last year's account, makes £5,729 14s. 11d., and which the directors propose to deal with as follows:—

	£	s.	d.
To pay a dividend (less tax) at the rate of £6 per cent. for the half-year ended December 31st, 1895, making with the interim dividend paid in August, 1895, £5 per cent. per annum for the whole year	4,350	1	2
And to carry forward	1,379	13	9
	£5,729	14	11

	1893.	1894.	1895.
Total capital invested	£205,854	£211,762	£220,000
Number of units sold	934,276	1,115,609	1,383,813
Number of lamps connected ...	34,570	41,216	51,202
Revenue from sale of current...	£20,597	£23,521	£27,859
Net revenue	—	£10,395	£12,587
Average price obtained per unit	—	5·06d.	4·80d.

Cost of Production.	£	s.	d.		Per unit.
Coal	5,278	0	0		·92d.
Oil, waste, water, and engine room stores	454	0	0		·08d.
Salaries and wages at generating station	2,909	0	0		·50d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,929	0	0	{Works' cost 1 83d.}	·33d.
Rates and taxes	279	0	0		·05d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,742	0	0		·30d.
Depreciation of buildings and plant account	3,000	0	0		·52d.
Renewal fund account	—				—
Total	£15,591	0	0		2·70d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	27,859	0	0	4·80d.
Meter rents	347	0	0	—
Sale of lamps	—			—
Total	£28,206	0	0	4 80d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·18d.; works' cost, 1·83d.

The Westminster Electric Supply Corporation.

Mr. J. H. Powell presided at an ordinary general meeting of the company, held at Eccleston Place, on Wednesday. In his opening remarks, he regretted the absence of Lord Suffield, who had been recently suffering from a severe illness, but was now recovering. The accounts would be satisfactory to every shareholder, which he thought proved that the public were becoming aware of the advantages of the electric light, not only that it gave the best illuminating power, but was accompanied by no vitiation of air to disturb the enjoyment of life or health. They had further found their system to be safe and reliable as well as inexpensive. Not only was there a considerable increase in the number of lamps installed, but the increase in numbers steadily went on. It had climbed up from 167,703 installed on the 1st January, 1895, to 210,982 at the end of that year, which gave an increase of 43,279. Applications had also been received for 6,478 in addition to those already installed in the previous year. Both in the number of consumers and lights, there was a substantial increase, and that increase was being steadily maintained, although the field they drew upon had decreased. As might be expected, the capital expenditure had increased to the extent of £33,000, about 8 per cent. of the previous capital. They had the very gratifying fact that the revenue had increased in a very much higher proportion, the increase being one of 33 per cent. They regretted to notice the increase in the charge for fire insurance. They had taken every possible means they knew of to make their buildings practically fire-proof, and had on the premises every mechanical appliance for extinguishing fire, and the men were drilled into the use of the appliances. The receipts per lamp were only fractionally higher than in 1894. The increase in the business was not spasmodic, it was all along the line, and whether they regarded it from number of units sold or from the number and class of their customers, all pointed to a general appreciation of a brighter and safer light, and the best preservative of internal decorations ever produced; that was a characteristic of electric lighting which should not be overlooked in calculating the cost of it. Shareholders apparently differed very much as to how much should be carried to depreciation. Some had gone out of their way to commend the judgment of the directors in placing so large a sum to reserve, very few had expressed an opinion that a sum of £9,784 was an excessive amount to put by. They had acted on the advice of their eminent consulting engineer, Professor Kennedy, who had allowed different per centages on different plant. He, the chairman, had seen in other undertakings the very evil effects arising from wrong practice in dealing with the item of depreciation. He spoke on a previous occasion of the necessity of establishing a sinking fund to provide for the recoupment of money paid for their leases, and a reserve fund to provide for any contingency. He hoped no misfortune would arise; but in the event of any accident befalling them at a time when their business was drawing to a close, a real reserve fund invested outside their business would prove very useful. And even if no contingency arose, such a reserve fund would be a very pleasant bonus to receive at the end of their career. They had therefore invested a sum of £3,773 as the nucleus of a reserve fund, and the £8,000 premiums on shares issued last year, and the interest and compound interest would bring that fund to a very respectable sum in a very short time. They had lately acquired property which adjoined their works at Eccleston Place and Millbank Street, which would be used for extensions when necessary. It was necessary in the interests of the shareholders that they should possess the land before they required it, for if their wants were known to be immediate, prices would be raised. This property was being let at a remunerative rate.

The Chairman then moved the adoption of the report and accounts, Mr. Boulnois seconding. One or two questions were asked, and the accounts were then adopted.

A resolution was passed, making the Board of Trade Auditor, the sole auditor of accounts.

India-Rubber and Gutta-Percha Works Company, Limited.

The ordinary general meeting of this company was held at the Cannon Street Hotel yesterday, Mr. S. W. Silver presiding.

In moving the adoption of the report, the Chairman said he could congratulate the shareholders on the result of the operations of last year. They had passed through a period of many changes, not the least effect being the trade of the country, which had greatly improved; the works having been kept prepared and ready, they were in the position to meet any demand made upon them. The general business had been good throughout. The electrical department had been fully employed in the erection and installations for several important cities, including Brussels, which he referred to last year, which was considerably extending and increasing its demands upon them. They had manufactured and laid in less than three months, 300 miles of submarine cable for the Cuba telegraphs, which was acknowledged by the engineer to be carried out in a way which showed admirable organisation. This had given employment to their two steamers. The works at Silvertown had been very well occupied since the commencement of the year. Six hundred miles of submarine cable had been supplied in excellent order, and to the entire satisfaction of the directors and of the Japanese Government. The factory in France was well employed. There was an alteration proposed in the way of making up accounts suggested by their auditor. He referred to the loss from the board of Mr. Anderson, and finally moved the adoption of the report and accounts.

A Shareholder asked some questions about the valuations to which the auditors had been unable to certify.

The Chairman said to give more details would only provide their competitors with valuable information, which would be used against them.

After some further remarks, the reports and accounts were adopted.

The National Telephone Company, Limited.

Report of the directors for the half-year ending December 31st, 1895, states that the income accrued in respect of the business of the half-year amounts to £422,649 6s. 9d., as compared with £378,789 4s. for the corresponding period of 1894, being an increase of £43,860 2s. 9d. The working expenses for the half-year amount to £216,537 0s. 5d., as compared with £205,192 12s. 10d. for the corresponding period of 1894, being an increase of £11,344 7s. 7d. The net result for the half-year (after deducting the Post Office royalties amounting to £38,238 12s. 1d.) is a profit balance of £167,873 14s. 3d., as compared with £138,642 14s. 6d. for the corresponding period of 1894, being an increase of £29,230 19s. 9d. The rentals carried forward for unexpired terms of running contracts amount to £354,635 12s. 1d. as compared with £313,979 3s. 4d. at the corresponding period of 1894, or an increase of £40,656 8s. 9d. Out of the available balance of £138,217 3s. 11d. shown by the net revenue account (No. 3) the board will recommend the payment of a dividend at the rate of 6 per cent. per annum, less income tax, on the first and second preference shares, 5 per cent. per annum, less income tax, on the third preference shares, and 6 per cent. per annum, free of income tax, on the ordinary shares. The board also propose to transfer £35,000 to the reserve fund, and to carry forward the balance of £6,623 7s. 11d. The report for the half-year ending June 30th, 1895, contained the following paragraph:—"The draft of the formal agreement with the Post Office, for the acquisition by the Department of the company's trunk lines, having been laid upon the table of the House of Commons in accordance with the promise of the Postmaster-General, the preliminary agreement requisite to give effect to the arrangements was duly executed and completed on March 15th last. The difficult and somewhat complicated details connected with the transfer of the company's trunk lines are approaching completion, and payment of the purchase money, now in process of being ascertained, may be expected shortly." In respect to this, it may now be stated that the many difficult questions involved in the settlement have led to some further delay. Happily, however, the amount due to the company is now practically agreed upon, and there is reason to believe it will very soon be paid. In the meantime, the board are loyally co-operating with the Post Office in preparing for that transition in the conduct of the trunk business of the country which will follow the assumption of the trunk lines by the State. The board have recently had to lament the loss of an able and distinguished colleague in the death of Sir Henry G. Calcraft, K.C.B., who had only since the date of the last report been elected to fill the vacancy caused by the retirement of Col. Jackson.

At yesterday's meeting, held at Cannon Street Hotel, Mr. J. Staats Forbes presided as usual. In moving the adoption of the report and accounts, he stated that they had striven to make the report itself, through the medium of the figures, as intelligible as possible. Following the various paragraphs of the report one by one for the purpose of showing the exact position of the undertaking, he stated there had been a substantial increase in the aggregate income of the company for the half-year of about £43,860, or equivalent to 11·58 per cent. additional income. The working expenses had increased by £11,344, or equivalent to 5·52 per cent., the result being that in the balance of profit available there was an increase of £29,231 or equivalent to 21 per cent. Referring to the tables in the report showing the abstract of half-yearly accounts and the results of the complete years 1894 and 1895, he said that those few lines of figures told the whole story. He went in detail over the various items of income and expenditure for the half-year, and the respective percentages as compared with the corresponding period of the previous year. He then proceeded to deal with the results for the complete year, which was shown very clearly in one of the tables referred to. For the year ending December, 1895, there was an increase in gross revenue of £80,353; Post Office royalties, increase of £7,452; working expenses showed a moderate increase. The net income for the year was £320,195, or £41,000 increase. Working expenses had diminished on the whole percentage. Debenture and other interest had increased £14,000. To the reserve fund £70,000 was carried, which was £11,000 odd in excess of the previous year. Out of the available balance the board recommended the payment of a dividend of 6 per cent. on the ordinary shares. That increased dividend opened a new state of things. Some years ago they paid 6 per cent. fairly regularly; but in the face of the combinations of the companies, the competition which threatened them, and the sacrifices which the board foresaw they would have to make in reference to the New and Mutual Telephone Companies, and all those combinations which were got up and run in order to be bought off, they thought it prudent to restrain the dividend, and reduce it to 5 per cent. Since then they had had three or four years' experience, and are now able to estimate not only the probability of the advantage of extension of the business, but also able to discount with a little more accuracy the agitation which is continually being carried on in order to get up opposition to the National Company. In face of these conditions, they had thought it right to give the shareholders the additional ½ per cent. He was so little accustomed to dividend-declaring in the concerns with which he was connected, that the increased dividend was one of considerable novelty to him, but he was keen enough to apprehend that there would be no opposition to the recommendation. £70,000 is carried to the reserve fund, and a balance of £6,623 carried forward. Regarding the agreement with the Post Office, which, as the report stated, had been executed, this had been about a very long time, and might just as well have been agreed to a year ago, but it was interrupted by a Parliamentary Committee, which had issued, as a first instalment, a blue book of the evidence heard. The agreement had been executed by the Postmaster-General, and is now a valid and binding agreement on both parties. The company were now waiting to be paid. The amount due was practically agreed; it was what they were to receive in exchange for the surrender of the trunk wires, but many important matters of detail regarding their future arrangements with the Post Office and the public were also dealt with. What was going to happen he did not know, but he hoped that the Post Office and the company would so work in harmony, that the public would not appreciate or find any very great inconvenience from the change which must ensue from splitting the business into two portions. He thought the company would protect the public against any inconvenience of that sort. They would take their money with a certain amount of confidence, but he supposed they would really have preferred to remain as they were before. The change would doubtless make the local exchanges more valuable. The company looked to that as one of the sources for the growth of the future income, and for the multiplication of subscribers. The amount they were to receive from the Treasury was an equitable one, but at the moment it was unadvisable to mention the exact figures. Regarding competition, he said he did not propose to volunteer any remarks upon the competition which was talked about, and fallacies which were spread broadcast all over the country. In Stockholm, one could get a house for £50 that would cost £500 in London, and all the conditions of life there are subject to some such comparison, whether domestic service or other elements of contribution which a commercial company or a householder has to face. But as Stockholm was not London when the analogy was applied to telephones, it should be in the proportion to the standard values of Stockholm. Anybody could understand the conditions were not the same for telephoning in London as there. Yet this Stockholm thing was drummed all over the country, and someone was coming to London to give a telephone service for £5 or £6 per annum. They would not delude themselves that that was possible, and he would not like to try to induce National shareholders to increase the capital in order that they might provide telephones in London, or any great centre, for £6, or anything like it. They must not be alarmed at the combination of defence which was going on against the "extortionate etceteras" of the National Company. Whatever arose the company would prepare to meet it, and with the advantage that they know the facts, and that certain "hair-brained philosophers" do not. The company had 82,093 subscribers of a class who represented a great deal more in the active control of commerce than a great many hundreds of thousands of the ordinary population, and those 82,000 were growing at the rate of 8,000 or 9,000, and great quantities of capital had to be found each half-year in order to take them on. Every new subscriber brought on in 1895—and there were 8,740—cost on an average £38 13s. 2d., or a total outlay of £337,000 odd. Each year they found the figure under this heading somewhere about this sum. These were actual cost figures and *facts*. Yet those people are going about the country, and going to do it all for £6. He concluded by moving the adoption of the report and the declaration of dividend.

This motion was seconded by Lord Harris, who had lately joined the board, and was carried with acclamation, a vote of thanks to the board and staff closing the meeting.

The British Electric Traction (Pioneer) Company.

The statutory meeting of this company, was held at Winchester House, yesterday.

The Chairman (Sir C. R. Wilson), in making some observations on the position of the company, said they were promoting Bills for the electrical working of tram lines between Kidderminster and Stourbridge, and between Ashton and Oldham. They were also in negotiation in other matters which it was not easy to refer to, but the two instances mentioned did not by any manner of means constitute the limits of their operations in progress. Speaking with regard to the electrical system which would be introduced in the future, the chairman said there was a great deal to be said in favour of the overhead trolley system, but there were certain features of unpopularity and inconvenience —the unpopularity was rather on æsthetic grounds—and inconvenience with regard to crowded streets. He and his colleagues had visited the Bristol line, which was the latest development of this system, and he would say that the inconveniences had been reduced to a minimum. If carefully carried out, the trolley system had much to recommend it, but there were the objections to which he had referred. They had turned their attention in other directions. There were in some places conduit systems with an open slot, which also had its practical inconveniences, and was also extremely expensive. They had acquired the right to a system, the result of the work of a most intelligent and eminent engineer, which partakes of the nature of the open conduit system, but which would be unattended by any inconveniences, and would be extremely economical. He felt very sanguine, but it hardly behoved him to ask the shareholders to share his view, but if his expectations were realised and experiments were in progress, they would be of the greatest possible advantage for the company that succeeded theirs. Their company was entirely a financial company; their object was to set in train a number of promising undertakings that would enable them to come before the public in a very short time. In concluding, the chairman spoke of the debt they owed to Mr. Garcke, and the proceedings terminated.

Hooper's Telegraph Works Company, Limited.—All persons holding certificates of the bonus appropriation made in February, 1873, of the capital in the Great Western Telegraph Company, Limited, are requested to apply at once to Mr. J. O. Chadwick for the shares to which they are entitled, of the proceeds of the above-mentioned bonus appropriation, at his offices, 95, Finsbury Pavement, E.C. The trustees retain the right of paying the balance of proceeds remaining undistributed at the expiration of a calendar month from the date of this notice into Court for the account of such claimants thereto as may appear and be admitted by the Court.

Isle of Man Electric Tramway Company, Limited.—The company, on Monday, issued notice to the shareholders, stating that the company intended to apply for sanction, at an extraordinary general meeting, to purchase the Snaefell Mountain Railway for £72,500, the purchase money to be payable as to £32,500 in cash, and £20,000 in fully-paid 6 per cent. £1 preference shares, and £20,000 ordinary £1 shares. The company is to be asked to increase the capital to £175,000, by the creation of £25,000 new £1 preference shares.

House-to-House Electric Light Supply Company.—Mr. Wm. Page presided at a general meeting of the above company yesterday, and in moving the adoption of the report, stated that the business had gone on steadily increasing, and the number of connected lights were now 44,162, and the revenue had gone up from £5,070 in 1890 to £15,394 in 1895. There was an increase in the expenditure, but during the year they would effect savings in the coal bill owing to the substitution of improved plant. The report was adopted.

Kensington and Knightsbridge Electric Lighting Company.—Mr. G. R. Ryder, who presided at yesterday's meeting, said the report showed there was plenty of vitality in the company. The increase in main mileage was 1¼ miles, viz., from 18¾ to 20 miles; the houses and shops connected had increased from 908 to 1,107; the number of lamps from 80,678 to 94,780; the sale of electricity from 977,789 to 1,228,734 units; and the revenue from £9,289 to £10,988. The report was adopted.

Brush Electrical Engineering Company, Limited.—The first debenture stock transfer books of the Brush Electrical Engineering Company, Limited, will be closed from February 19th to March 3rd, 1896, both inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending February 16th, 1896, were £949; week ending February 17th, 1895, £998; decrease, £49; total receipts for half-year, 1896, £6,946; corresponding period, 1895, £7,089; decrease, £93.

The Liverpool Overhead Railway Company. The receipts for the week ending February 16th, 1896, amounted to £1,134; corresponding week last year, £843; increase, £291.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 14th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,818.

NOTES.

Obituary.—We regret to have to record the death of Mr. Andrew Bell, late Superintendent of the Gloucester Road Factory of the Postal Telegraph Department. Prior to 1852 Mr. Bell was engaged in construction work in connection with the Britannia tubular bridge, and in 1852 he joined the Electric Telegraph Company, and was engaged in various parts of the country until the spring of 1858, when he took up an appointment in India to superintend the erection of telegraphs for the Madras Railway Company. He continued to occupy this post until the spring of 1864, when he was invalided home, and for two years his health prevented his accepting any appointment. In the spring of 1866 he was selected in conjunction with Captain Moxon to examine telegraph engineering stores for the Indian Government Telegraphs, and he was more or less constantly engaged on this work until the end of 1869. In 1870, on the retirement of Mr. J. Muirhead, he was appointed superintendent of the Postal Telegraph Factory at Gloucester Road, and continued to occupy that position until his retirement in 1887. The experience he had gained of construction work during the erection of the Britannia Tubular Bridge was of particular advantage to the Post Office, and during the days shortly after the transfer, he was almost invariably referred to on all questions respecting structural ironwork, and the practical knowledge he had acquired of timber, and of telegraph construction generally, were of the greatest use to the service. He had a particularly sound knowledge of practical mathematics, and although his method of solving a problem was in some cases perhaps not the most expeditious, he never failed to arrive at a practical and accurate result. He was one of the earliest members of the Society of Telegraph Engineers (now the Institution of Electrical Engineers), and up to the time of his retirement, kept himself fully posted as to all the latest methods of testing, and improvements in apparatus. A quality which particularly endeared him to all who were associated with him was his willingness to impart information, and he would willingly occupy himself for hours in assisting one of his colleagues to solve a difficulty, or to give him information as to the best practical method of carrying out any work or instruction on any branch of engineering. He died in his 70th year at Portobello, Midlothian.

We regret to hear of the death of Mr. John A. Bird (after a very short illness), the managing director of Messrs. Rose and Bird, Limited. Arrangements have been made so that the business will be carried on as usual.

Autocars.—It is very certain that when the legislative hindrances are removed, there will be a big business done in self-propelled vehicles of all kinds. The Daimler Motor Company, Limited, which has just issued its prospectus, inviting subscriptions for £60,000, therefore comes at an opportune moment.

During the last few days, the exhibition of horseless carriages has been held at the Imperial Institute. Legislators and others have been testing these new vehicles for themselves, and apparently have received convincing proof that there is nothing to fear from their free use upon the public thoroughfares.

Sir David Salomons has written to the financial papers for the purpose of correcting the impression that he is in any way connected with, or interested in, the Motor Car Club, or the Daimler Motor Company. It is "a source of satisfaction" to Sir David to state that he is "not connected with either in any way whatever." The London correspondent of the *Times of Ceylon*, also writes correcting one of the statements in the prospectus.

Dealing with Apparent Death from Electric Shock.—We understand that our suggestions for treating persons who have received a severe electric shock were successfully applied at the Salford Corporation Electricity Works recently, when one of the men employed there came in contact with a current having a pressure of 3,000 volts. Artificial respiration was resorted to, and the man revived. [Copies of our suggestions for dealing with apparent death from electric shock may be had gratis on application.]

Should Armature Discs be Keyed?—The question of keying a core disc firmly to the shaft has been the subject of frequent discussions among designers and builders of dynamo-electric machinery in the States. It has been argued, says the *Electric Railway Gazette*, that the laminæ being held in the vice-like grip of the end discs, were sufficiently secured mechanically, and that only the end discs need be keyed. In railway work almost all armatures are slotted, and the problem is altogether different from the case of smooth core armatures. The drag on the armature comes directly upon the wire in the case of smooth core armatures, whereas, in the case of slotted armatures, the field of the armature wires is included in the teeth of the core discs, and hence considerable stress comes directly upon them. Therefore, slotted core discs should always be keyed, but as smooth body core discs are not subjected to twisting movement, keying them to the shaft is not so necessary, provided, of course, that the end discs positively drive the coils (or *vice versâ*) by means of projecting lugs. Armature laminæ, interspersed with paper discs, are not capable of maintaining their position when held in place by simple compression. The heating and cooling, combined with mechanical jar, reduces the paper to a fine powder, and loosens the discs. If there is a drag on them, the looser ones may yield, and as this drag occurs only in slotted armatures, the insulation of the armature wire, embedded as it is in its groove, may be seriously abraded.

International Horse and Horseless Carriage and Roads Locomotion Exhibition, London, 1896.—Our readers will probably be pleased to hear that at the forthcoming exhibition, to be held at the Crystal Palace, of all things appertaining to carriages and autocars, the interest of electrical engineering will be carefully watched over. We understand that Mr. A. R. Sennett, A.M.I.C.E., M.I.E.E., has accepted the position of Honorary Executive Commissioner. In addition to the class for electrically propelled vehicles, there will also be those for electromotors, special gears, accumulators, primary batteries, &c., as well as accessories, such as electric lamps for the lighting of vehicles, tricycles, &c. The classification is not yet quite complete, and the Executive Commissioner would be glad of any proposals readers may care to send to him, addressed to the Crystal Palace. Mr. Sennett is anxious to see electric vehicular propulsion and traction take its fair position, and he will be glad to receive as soon as possible particulars from such of our readers who may be proposing to exhibit electrical vehicles in action, as to their requirements in regard to the recharging of accumulators, in order that proper provision may be made.

Accidents due to Gas.—At the Royal Military College, Camberley, a gas explosion occurred in one of the rooms, the door of the room being smashed, the walls damaged, and the occupant injured so seriously as to necessitate immediate removal to the hospital.

The Appeal Court on 17th inst., in reversing Mr. Justice Wright and a special jury's decision in the case of Hardaker and another *v.* The Idle District Council and Thornton, entered judgment for the plaintiffs, who were injured through the explosion of gas which found its way into their premises, for £45 against the District Council, which they held responsible for the negligence of Thornton, by whom the gas pipes were broken.

A gas explosion occurred at St. Andrew's Mission Room, Leeds, on 11th inst., slightly injuring the Vicar and another gentleman.

The son of Mr. Geo. Garton, Huddersfield, the inventor of a machine for making acetylene gas, was taking the apparatus to pieces for cleaning when he was blown off his stool and hurled along a passage to the front of the offices. He was seriously injured.

A gas explosion which occurred at Victoria Colliery Level, Blaengarw, Garw Valley, on Monday, killed one man and injured two others.

Quadruplex Telegraphy.—Recent experiments made by Mr. W. Finn in the United States, with reference to the "K R" law as applied to quadruplex circuits, have proved that on a line whose K R is 10,500, excellent working is obtained, but with 36,000 it was impracticable. Between these limits are, of course, to be found good, bad, and indifferent grades of working.

Researches on the Cyanide Process.—Students of the cyanide process, of which the devotees claim that it is revolutionising the gold output of the world, should not miss an important paper which is to be found in the *Zeit. Physikal Chem.*, xvii., pp. 513—535. It is a long paper, and unsuitable for extended notice in these pages. However, the leading features may be thus summarised. The author dealt with silver chiefly, and determined the E.M.F. of the following chains, viz. :—(1) $Ag/Ag\ NO_3\ (N/10) - K\ NO_3\ (N/7) - K\ Cl\ (N/1)\ Hg\ Cl/Hg$; (2) $Ag/K\ Ag\ (CN)_2\ (N/20) - K\ NO_3\ (N/1)$, &c.; and (3) $Ag/(K\ Ag\ (C\ N)_2\ (N/20) + M\ C\ N) - K\ NO_3\ (N/1)$, &c. From this determination can be calculated the E.M.F. between (1) the $K\ Ag\ (C\ N)_2\ (N/20)$ and the $Ag\ NO_3\ (N/10)$, and (2) the $[K\ Ag\ (C\ N)_2 + M\ C\ N]$, and the $Ag\ NO_3$. Hence is obtained the ratio of the concentration of the silver ions in the two cyanide solutions, and from this ratio the concentration of the cyanide ions in the added cyanide, M C N. Equations are given to show the dissociation of the double cyanide, the concentration of the cyanide ions being about $2{\cdot}76 \times 10^{-8}$ N, and of the silver ions about $3{\cdot}65 \times 10^{-11}$ N, in a N/20 solution. In similar salts the dissociation is shown to be similar. The dissociation constant of hydrogen cyanide is found to be $2{\cdot}6 \times 10^{-9}$—a number agreeing very well with Van Laer's calculated value, $3{\cdot}1 \times 10^{-8}$.

Manchester and its Telephone Service.—The agitation which has been proceeding at Manchester for a municipal telephone system is evidently not so deep-rooted as at first seemed to be the case. On Tuesday a town's meeting, called by the Lord Mayor, and presided over by him, considered the question of the Corporation undertaking to provide a system for Manchester and the district. There were present at the meeting, which was very large, the leading merchants and manufacturers of the city. A resolution in favour of applying to the Post Office for the necessary powers to carry out the project was rejected by a very large majority.

Electrical Development in Venezuela.—The Campania Anonima la Electricidad, of Caracas, intends developing power from two falls in the El Guaire River, the power to be electrically distributed to Caracas, and used there. The company's representative has recently visited the Niagara Falls with a Westinghouse Electric Company's man and inspected the power plant there. A transatlantic exchange says that the combined heights of the two falls is 345 feet, and they will develop 3,000 H.P.

The Cyanide Process.—The hearing of the action brought against the African Gold Recovery Company, to decide the validity in South Africa of their patent rights in the cyanide gold extraction process, commenced at Pretoria on Monday. Mr. James Hay, the plaintiff, appealed, on behalf of the mining industry, for the cancellation of the patents of the company, on the ground that the process had been previously used in connection with mining, and was not invented by the defendants.

The Institution of Electrical Engineers.—On Thursday next, February 27th, 1896, the discussion on "The Electric Wiring Question," by F. Bathurst, Associate, and "Concentric Wiring," by Sam. Mavor, Member, will be concluded. A paper will be read by G. L. Addenbrooke, Member, on "High Voltage Lamps and their Influence on Central Station Practice."

Lectures.—Before the Dundee Naturalists' Society on 12th inst., a lecture on "Electric Vibrations" was delivered by Prof. Kuenen, who was lately appointed to the Harris Chair of Physics in University College.

On 11th inst. Mr. R. Rivers, of the Telegraphic Department of the General Post Office, lectured in the North Hall, Green Street, Sunderland, on "Telegraphy: Its Rise and Progress."

Transmission of Power in Mexico.—A contract has recently been placed with the representative of Messrs. Siemens & Halske, in Mexico, for the transmission of water-power from falls at Tenancingo to the City of Mexico, the Federal district, and neighbouring States.

A Natural Result.—A member of the Guildford Town Council, last week, stated that although the Council was paying the gas company 13s. extra per annum for each lamp to which the incandescent lights were attached, he had noticed that for a fortnight or three weeks some of the mantles had been broken, and they only gave half the usual light.

The Hampstead Fatality.—Many of the Vestrymen and electric lighting employés at Hampstead, as well as similar employés at Bristol and Derby, are very generously subscribing to a fund which is being raised on behalf of the parents of the deceased Clarkson, who, previous to his fatal accident at Hampstead central station, was their sole support.

A Non-Packing Granular Telephone Transmitter.—In an arrangement designed by Mr. S. A. Dinsmore, of Chicago, the receptacle holding the carbon is provided with a toothed rim, which gears with a wheel driven by the handle that operates the magneto-call. When a ring is made the transmitter is thus revolved, and the granules in it shaken up. This, we would remark, is practically identical in principle with the arrangement described on page 514 of our issue of October 25th, 1895.

The Northern Society of Electrical Engineers.—On Monday, February 24th, at Manchester, a paper will be read on "The Development of Electric Lighting Engines," by H. Lindley, Member.

Erratum.—In a short notice of the Levetus primary battery on page 253, for the word *zinc*, in line 14, read *iron*. D'Humy used iron in his famous "water battery," and many others have employed the same metal.

NEW COMPANIES REGISTERED.

Electric Light Insurance and Maintenance Company, Limited (46,867).—This company was registered on February 14th with a capital of £10,000 in £1 shares, to enter into contracts, and issue policies of insurance, for the maintenance, in proper order, of all electrical appliances, and to carry out contracts for electric lighting. The subscribers (with one share each) are:—W. M. Maxwell, 120, Bishopsgate Street, E.C., secretary; T. C. Crawfoot, 36, Olenda Road, Stamford Hill, gentleman; R. H. Webb, 20, Ruskin Road, Tottenham, solicitor; W. Bowles, 101, Raleigh Road, Hornsey, clerk; R. H. W. Hanna, 134, Cassland Road, Hackney, gentleman; W. Webb, 39, New Broad Street, E.C., solicitor; H. W. Webb, 166, Church Street, Stoke Newington, solicitor. Registered without articles of association. Registered office, 120, Bishopsgate Street, E.C.

Brook Time Checking Clock Company, Limited (46,879).—This company was registered on February 15th with a capital of £5,000, in £1 shares, to acquire the business of a clock manufacturer carried on by F. Brook, at Market Street, Huddersfield, as "Frank Brook & Co.," to adopt a certain agreement, and to carry on business as checking clock manufacturers, clock and watchmakers, repairers, and agents, manufacturers of and dealers in electric batteries, electric clocks, &c., electricians, &c. The subscribers (with one share each) are:—F. Brook, 94A, Market Street, Huddersfield, clock manufacturer; J. C. Arrol, 8, Devonshire Street, Lockwood, Huddersfield, foreman; S. A. Robinson, 3, Grafton Place Huddersfield, agent; T. Brook, 11, South Parade, Huddersfield, engineer; R. H. Robinson, Cleveland Road, Huddersfield, plasterer; F. Marsland, 13, Commercial Street, Huddersfield, brewer; A. Money, 119, Gillott Road, Birmingham, traveller. The number of directors is not to be less than three, nor more than seven. Qualification 50 shares; remuneration as the company may decide. Registered by Alfred H. Atkins, Limited, 23, Bouverie Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Guildford Electricity Supply Company, Limited (36,725).—This company's annual return was filed on December 31st. The capital is £20,000 in 3,900 £5 ordinary shares and 500 £1 founders' shares. 974 ordinary and 482 founders' have been taken up, and £2 per share has been called on the ordinary, and £1 per share on the others. £1,785 has been paid, leaving £928 in arrears. The sum paid includes £283 paid in advance.

Universal Electric Carriage Syndicate, Limited (45,378).—This company's registered office is now situated at 3 and 4, Crooked Lane, King William Street, London, E.C.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation Feb. 11th.	Closing Quotation, Feb. 19th.	Business done during week ended Feb. 19th, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	..
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	— —	10¼— 10⅜	10½	10 3/16
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	47 — 49	45 — 48 xd	47¾	46
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	88½— 89½	87 — 88	87¾	87
2,993,560£	Do. do. Defd.	Stock	...	...	...	7½— 8	7½— 8	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	7 %	...	14½— 14½	14— 14½	14 7/16	14
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	110 —114	110 —114	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	...	3½— 3⅝	3½— 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	160 —170	160 —170	...	...
224,850	Consolidated Telgp. Const. and Main., Ltd.	10/-	2 % §	1½%	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½— 13⅛	12½— 13½xd	13½	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½— 21½	20½— 21½xd	20⅝	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	...	104 —107	104 —107 %	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	...	9 — 9½	9 — 9½	9⅝	9
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	...	17 — 17½	17 — 17½	17⅝	17 1/16
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	...	18 — 18½	18 — 18½	18⅝	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	105 —108	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	127 —130	128 —131	129¼	129
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17½— 18	17½— 18	18	17 11/16
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	100 —104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	126 —129	127 —130	128	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	105 —108	105 —108 xd	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	112 —115%	112 —115 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅜% §	4½%	...	10 — 10½	10 — 10½	10⅝	10 1/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	...	16½— 17	16½— 17	17	16½
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	...	22½— 23	22¼— 22⅜	22⅞	22¼
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	104 —107	104 —107	...	..
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	46 — 49	46 — 49	48¾	47
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs. ...	100	6 %	6 %	...	107 —111	107 —111	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5½%	6½— 6⅝	6⅜— 6¼	6⅞	6⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16 — 17	16 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6¼— 6⅜	6⅜— 6⅝	...	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —107	104 —107	105½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4¼%	...	9/16— 11/16	9/16— 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	108 — 111	108 —111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	...	4½— 5½	5 — 6	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	128 —133	131	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	...	3 — 3½	3 — 3½	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	94 — 99	93 — 98	95½	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	...	5½— 6½	5½— 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	102½	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	94 — 99	94 — 99	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	...	8⅝— 9½	8⅝— 9½	9¼	8⅞
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	6½— 7	6½— 7	6 11/16	6½
33,129	Do. do. do. Def. Ord.	7½	...	1 %	...	3 — 3½	3 — 3½	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	102 —105	102 —106	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	102 —105	102 —106	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	¼%	...	1 — 1½	1 — 1½	1 1/16	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	10½— 11	10½— 11	10 15/16	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	...	113 —118	113 —118	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	...	102 —105	104 —107	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	5½— 5⅝	5⅝— 6¼	5 15/16	5⅝
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	6⅜— 7¼	6⅜— 7¼	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	115 —118	115 — 118	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	14 — 15	14 — 15	14⅜	14⅜
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16 — 17	16 — 17	16 11/16	16½
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	134 —138	134 —138	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8 — 9	8 — 9	...	...
10,000	Do. do. do. 6% Pref., £8 pd., 40,001—50,000	10	...	...	...	10½— 11	10½— 11	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5⅛%	...	7⅞— 8⅛	7⅞— 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	...	12 — 12½	12 — 12½	12 15/16	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	115 —118	115 —118	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	8½— 9	8½— 9	9	8 15/16
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	9½— 10	9½— 10 xd	10	9½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 9½xd	9⅞	9⅝
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	9¼— 9⅝	9¼— 9⅝	9⅝	9⅜

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Feb. 11th.	Closing Quotation, Feb. 19th.	Business done during week ended Feb. 19th, 1896. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	5 % §	2½%	...	1 — 1¼	1 — 1¼	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	3 %	...	1½ — 1⅝	1½ — 1⅝	1 1/16	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	115	...
830,000£	City and South London Railway	Stock	1 1/16%	1 1/16%	1 3/16%	40 — 42	40 — 42	41	40
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 % §	*nil*	...	2¼ — 2⅜	2¼ — 2⅜	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	...	1½ — 2	1⅞ — 2 xd	1⅞	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	...	3 — 4	3 — 4 xd	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	...	103 —106	103 —106 xd	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	⅝ — ¾	⅝ — ¾	11/16	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2 — 2¼	2 — 2¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅜ — 1	⅜ — ⅞	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅝ — ¾	¾ — 1	15/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil*	...	¼ — ⅜	¼ — ⅜	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	...	9½ — 10½	9½ — 10½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	...	13½ — 14½	13½ — 14½	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	...	16 — 17	16 — 17	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	108 —111	109 —112	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	20½ — 21½	20½ — 21½	21	20¾
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	103 —105	103 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅝%	13⅛ — 13⅜	13¼ — 13⅜ xd	13¼ xd	13 3/16 xd
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16 —16½	15⅞ — 16 xd	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	38 — 41	38 — 41	40	38
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	5⅛ — 5⅜	5⅜ — 5⅝	5⅝	5 3/16

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 189
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½%; 1890—6%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¾—6¼.

Electric Construction Corporation, 6 % Debentures, 100—105.

House-to-House Company (£5 paid), 3½—4.

Do. do. 7 % Preference, of £5, 7⅞—8¼.

Do. do. 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 7½—8; 1st Preference Cumulative 6 %, £5 (fully paid), 7¼—7⅞.

Liverpool Electric Supply, £5 (fully paid), 7⅞—8¼.

London Electric Supply Corporation, £5 Ordinary, ¼—⅜.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅞—7¼.

Bank rate of discount 2 per cent. (February 22nd, 1894).

ECONOMICAL RESULTS IN MODERN ISOLATED ARC LIGHTING.*

By F. E. DRAKE.

Much has been said and written about economies which might be practised in isolated lighting plants, but as yet very little actual data has been presented to the public bearing upon the cost of operating an isolated arc lighting plant, and showing what might be done with modern machinery if properly installed and then operated by careful and competent hands. The plant which is the subject of this paper is that owned by J. L. Hudson, the successful clothier, and lights his handsome store in Detroit, Mich. It was purchased in 1891 and installed under the direction and advice of well-known authorities on electrical and mechanical engineering of the University of Michigan.

The steam plant consists of return flue tubular boilers and modern high speed automatic engines, all well placed and equipped with devices and accessories for economical operation.

The electric plant as installed consisted of five "Standard" arc dynamos of 40 lights capacity each, 205 "Standard" double-service arc lamps, and a 200-light direct current 110-volt dynamo wired for full capacity. The plant was formally started September 1st, 1891, and has been operated every working day since.

By courtesy of Mr. A. F. Chappell, Chief Engineer, who has been in charge of the plant since completion, an itemised account of the operating expenses has been furnished the writer. The record is in detail for the full period of four years and four months from September 1st, 1891, to January 1st, 1896. Time and space is too limited to show the detailed record for each year, but for a comparative basis the expense for the year 1895 is given. In the item of repairs on dynamos, the $335.44 includes $200 expended in changing one of the 40-light arc dynamos into a 50-lighter.

In arriving at the average cost per lamp, the 200 incandescent lamps are computed as the equivalent of 20 arcs. Each arc lamp is adjusted to 50 volts, and the dynamos being wound for 10 amperes, it will be seen that each arc consumes 500 watts. The following table shows the record of output.

	For 4 years and 4 months.	For 1895.
Arc lamp hours	1,527,538	351,658
Arc kw. hours	763,769	175,829
Incandescent lamp hours ...	2,735,766	1,038,836
Incandescent kw. hours ...	150,467	57,136
Cost per kw. hour	...	$0.03145

In reviewing the cost per lamp for 1895, one will note in the table that the three chief items of expense are $13.79 for labour, $9.71 fuel, and $2.75 for carbons, figures which are quite phenomenal when the output is considered.

Perhaps the most startling figures shown is the extremely low cost of dynamo and lamp repairs. In 1895 the total of dynamo repairs, including brushes, was $30.85, or $5.14 per dynamo. Can a better showing be hoped for? The 205 arc lamps had repairs to the extent of $85.90 or 42 cents per lamp, which covered all globe breakage. These results are well worthy of emulation, and show conclusively that the oft repeated cry of "economy" has been heard and heeded by the owner and operators of this plant.

Instead of giving the lighting plant credit for exhaust steam at its estimated value, Mr. Chappell has made the set off by reducing the depreciation percentage on the engines and shafting, and the interest charges on a sum placed at

* New York *Electrical Engineer.*

$6,000, which the owner, after several years' experience, testifies to as being fair and equitable.

Every station man may study these results with some degree of benefit to his plant and purse, and we can none of us afford to say, or believe that we have practiced all economies possible in generating and distributing electrical energy, whether it be expressed in arc or incandescent lights or power.

DETAILED COST OF OPERATING 205 ARC AND 200 INCANDESCENT LAMPS IN THE J. L. HUDSON BUILDING, DETROIT.

Average in last column on basis of 225 arcs.	For entire period of four years and four months.	For the year 1895.	Cost per lamp, 1895.
Coal	$8,834.19	$2,185.70	$9.71
Carbons	2,979.31	618.00	2.75
Labour	14,012.09	3,102.43	13.79
Water for boilers	452.09	86.00	.38
Soap, soda, mops and brooms ...	128.76	12.35	.06
Cylinder, dynamo and engine oil ...	1,004.28	181.74	.81
White waste	165.15	29.82	.13
Incandescent lamp renewals ..	807.85	110.33	.49
Incandescent wiring	422.50		
Repairs on boilers and furnaces ...	794.66	311.33	1.38
Repairs on clutches and shafting ...	41.85	8.31	.03
Repairs and packing for engines ...	110.26	45.36	.20
Repairs on 205 arc lamps	163.02	85.90	.38
Repairs on six dynamos, including brushes	335.44*	30.85	.14
10 per cent. depreciation on boilers, $2,000	866 66	200.00	.88
2 per cent. depreciation on engines and shafting, $4,000	346.66	80.00	.36
4 per cent. interest on $6,000 ...	1,000.00	240.00	1.07
Total	$32,464.77	$7,328.12	$32.56

* $200 of this sum expended in an exchange.

SUPERHEATING.

PRESUMABLY as a result of our last article on superheating, we have received from Messrs. McPhail & Simpson copies of various tests made with their superheater, all of which show a very great increase in the evaporative duty of the boilers to which the apparatus was attached. The increased duty is not merely a relative increase in the weight of steam produced per pound of coal, but an increase also of the power of the boiler to produce steam, the increased efficiency not being at the expense of the total power as sometimes occurs with certain smoke preventers for example.

Mr. Patchell showed in his paper, to which we referred in our last article, that a boiler could be very materially augmented in power with safety, and without any of the undoubted priming, arising from an assisted draught, getting through to the engines. We take it that his experience of this particular form of superheater is favourable, and that it is to the peculiar arrangement whereby the superheated, and perhaps overheated, steam is led in pipes through the water in the boiler that the success of the superheater is due. Without some such device we may take it that it is conceivable that the steam might be heated to the temperature of red-hot iron, and that such a temperature would carry with it the germ of failure of the system as of old. Without some such device it would not be possible, in fact, to place the superheater tubes in the midst of such glowing gases as we find it is placed. The amount of superheat can be regulated by means of a bye-pass which will send any proportion of the steam direct from the superheater to the engines, or *viâ* the boiler pipes to be brought down in temperature to the desired limit. It is not difficult to picture an automatic regulating device, whereby the proportion of steam going by the two paths shall be regulated within a fairly close range of temperature. Half a dozen ways suggest themselves of accomplishing this end in a reasonably direct manner. So far the very great economy accompanying the application of the superheater as an improver of the boiler has militated against its genuine use as a superheater. Indeed, the economy thus secured has been credited wrongly to the principle of superheating, and this has become, we will not say undeservedly, popular for no just reason. That the principle of superheating will be acknowledged in due time on its own merits we do not doubt, but do not let us be carried away by other economies to neglect what is still to be obtained. So much is to be gained by an addition of, say, 100 degrees to the temperature of saturation that it would be waste not to attempt such. To those who would draw the line at a temperature limit lower than an additional 100 degrees would imply with the initial cylinder of a triple expansion engine, it may be suggested that there is no objection to the superheating of the exhaust steam from the first cylinder before it enters the second cylinder. True, this application of heat at what is a point along the exhaustion curve is thermo-dynamically wrong; but so is a steam jacket wrong in that sense, yet it is a practical economy like many theoretically imperfect methods, and where an economy is to be secured it were foolish to draw back from any regard for theoretical accuracy of procedure. The total possibility of superheat is probably beyond the reach of our existing materials to co-operate, and we must use the tools we have until better be forthcoming. We should be glad if Messrs. McPhail & Simpson would furnish us any results they may secure of the improvement in engine results from the use of their superheaters when arranged to give a considerable and unmistakable superheat right up to the engine.

THE LEVETUS PRIMARY BATTERY.

THE continual advent of so-called new forms of primary batteries which are to do marvels and to produce electricity at a mere nominal cost, suggests irresistibly that there are still many who are to a great extent convinced that they have really discovered a good thing when they are simply misled by their own lack of knowledge. It is unnecessary to allude to the numerous absurdities which we have from time to time chronicled and exposed in our pages; we shall doubtless have many more to criticise as years roll by, and enlightenment does not come. We have now before us two patent specifications relating to the Levetus primary battery, of which we have made mention before in our pages.* This battery is a couple with zinc (or other suitable metal) and carbon electrodes, and the first specification relates to the arrangement of the cells, whereby a free circulation of the liquid is claimed to be obtained. In the second specification a couple, preferably of iron-carbon, is described as follows:—

"We provide an outer containing cell of any suitable material and shape for containing the iron and carbon elements and the battery fluids, the said containing cell being divided into three compartments or chambers, the middle one of which is arranged to contain the iron and carbon elements, and the two other compartments serving as reservoirs for the exciting fluids. The iron element is preferably placed in the middle of the said inner chamber, the carbon elements being arranged on each side of the iron element, but separated therefrom by porous partitions.

"The carbon element preferably consists of a number of hollow carbon rods, which are arranged in any suitable manner, so as to expose a large surface to the action of the exciting fluid.

"The said hollow carbon rods are made of sufficiently porous carbon to allow the hydrogen gas bubbles, which are formed on their exterior surfaces, to permeate the walls of the said carbon rods and enter the hollow interior thereof, but the rods are not sufficiently porous to allow the exciting liquid to pass through them.

"The upper ends of the said rods are open to the atmosphere, whilst their lower ends are all connected to a hollow tube or chamber of carbon or other suitable substance. By these means, as the temperature of the battery fluids rises owing to the chemical action of the fluid on the iron element,

* ELECTRICAL REVIEW, September 6th, 1895.

the air in the hollow space within the carbons becomes warmed, and rises up and passes into the atmosphere, carrying with it the hydrogen gas that enters the interior of the hollow rods, its place being taken by the entrance of fresh cool air. The fresh supply of oxygen thus obtained, and the continual circulation within the carbons, materially assist in the oxidisation of the hydrogen gas, and thus prevents depolarisation (polarisation, it is presumed, the inventors mean). The fluids we prefer to employ in this battery consist of a solution of any salt or acid with a base of chromium, in conjunction with sulphuric, hydrochloric, or nitric acid, or a mixture of such acids, for the carbon element, and a solution of dilute sulphuric acid for the iron elements."

Granted that the whole arrangement is very ingenious, and doubtless there are points of ingenuity about it, what marvellous virtue does the combination possess that lifts it so much above an ordinary battery and makes it likely to furnish electricity at a cheap rate, which previous iron-carbon elements have failed to do. Assuming there to be a demand for large primary batteries, which we very much doubt, the Levetus combination will doubtless answer as well, perhaps a trifle better, than others which we could name; but that is all.

THE ACTION OF CONDENSERS IN CABLE WORKING.

The action of condensers in cable working as well as some other points may be illustrated by the usual hydro-mechanical analogue.

Electricity = an incompressible frictionless fluid without weight.
R, Resistance = friction.
K, Capacity = amount of yielding (under unit pressure) due to
Spec. Ind. Cap. = elasticity.
C, Current = flow of fluid $\pm$ according to direction.
E.M.F., Electromotive force = pressure acting on the fluid.

Take a tube of elastic material, the elasticity being of such a nature that its bore will expand or contract under internal or external pressure, but the material itself will always occupy the same volume; so that, starting with the tube full of the fluid and immersed in fluid, any addition of fluid inside is accompanied with an equal diminution of fluid outside. Every tube must have a bore, and this enclosing a material more or less pervious to the fluid, will constitute an insulated conductor, the actual capacity will therefore depend merely on the surface and the material of the tube wall. The action illustrated hereafter is that which occurs in every conductor, though the actual time of the variable state of flow may be so short as to be incapable of detection by the instruments adopted, or may be neglected in considering the part of the phenomena we wish to record.

The resistance to the flow inside and outside the tube is presented by the material being more or less porous through which the liquid has to be forced, the resistance, therefore, of any given material will, as there is no friction between the fluid and the material of the tube wall, be directly proportional to the length of the conductor and inversely to its section. The resistance to flow in the conductor may for the same reason be assigned to some inter-action of the particles of the conductor caused by the flow of liquid.

If the outside of the tube (earth) be formed of a very large volume, the actual resistance will be extremely small, even though the specific porosity may be comparatively small.

Affix a pump at one end of the tube, the other end of which is connected to earth, so that we can apply any given pressure to the fluid; as there is almost no resistance to the flow outside the tube, the immediate effect of this pressure will be to expand the tube at the sending end, as well as to force it along the conductor; this expansion will be proportional to the pressure at each point along the tube, and ultimately the pressure at each point will be proportional to the resistance between that point and the receiving end of the conductor, and the current flowing at the receiving end, and at any point of the circuit, will be constant and determined by the equation, $C = E/R$; and the tube will be expanded in the form of a cone with its apex at the receiving end.

A little consideration of the progress of events after the application of the pressure will show that there must be retardation in the arrival of any appreciable current at the receiving end, and also a difference between the form of the rise of current at the sending and receiving ends respectively, causing what we may term distortion in the received signal, because at the first instant the chief part of the current entering the tube will be used up in expanding the tube, this quantity gradually decreasing as time goes on; and as the quantity supplied by the pump to each portion of the tube is governed by the resistance of the conductor to such point and the difference in pressure, it is only the remainder which is not used up in charging that can reach the other end.

Mathematical analysis has given us the form of the arrival curve (see Jenkin's "Electricity and Magnetism").

Now, suppose the pump pressure taken off and that end put to earth, the elasticity of the tube tending to bring it back to its neutral position will force the fluid out from both ends of the tube, the amount flowing from each portion of the tube to either end being governed by the resistances between such portion and the two ends respectively, so that we shall get a current tailing off at the receiving end after the pressure is interrupted. Now, suppose a condenser applied between the pump and the end of the tube; this will consist of a vessel with infinitely small resistance, but with an elastic diaphragm between its inlet and outlet connections. If the vessel has sufficient capacity, the back pressure exerted by the diaphragm will not for the commencement of flow reduce the pressure to any great extent on the fluid in the cable, but as the fluid is forced into the vessel the same amount is forced into the pipe, and the diaphragm will continue to yield until its back pressure equals that of the pump, we shall thus obtain a gradually diminishing pressure on the fluid in the pipe, so that the outflow at the distant end will, at first, be almost the same as when the condenser was absent, but will increase more slowly to a maximum, and then fall still more slowly down to zero. Now, in signalling, we shall use only a very small portion of the arrival current, cutting off the pressure long before it has reached its maximum, we can, therefore, by increasing the pump pressure approximate as nearly as we like to the form of that portion of the curve which would obtain were the condenser omitted. The course of events after taking off the pressure will be very different, because the elasticity of the diaphragm will strive to draw much more of the liquid out at the sending end and thus reduce the amount which flows out at the receiving end, so that the tail will be considerably reduced. There will still, however, be a considerable amount of distortion; and matters under these conditions can be improved only by reducing the resistance and capacity, but naturally there will be commercial limits to this.

There would, however, be another possible method of reducing the distortion, viz., by introducing inertia in the path of the current flow outside the tube or in the tube wall, so that the tube could not expand immediately on the application of the pressure, but only gradually; thus inertia would act like negative capacity to an increasing pressure, and the current sent along the tube would be greater at the earlier stages, and so distortion would be reduced.

Adding inertia would, under certain conditions of numerical values, introduce oscillatory charge, because the momentum would carry the tube wall past its proper position, the elasticity would cause it to return again below its proper position, and so on, until friction had brought it to rest; and a similar result would occur on discharge.

By proper timing of the application of the impressed force at intervals consonant with these oscillations, the resonance thus set up would cause disruptive effects equivalent to that of enormous pressure.

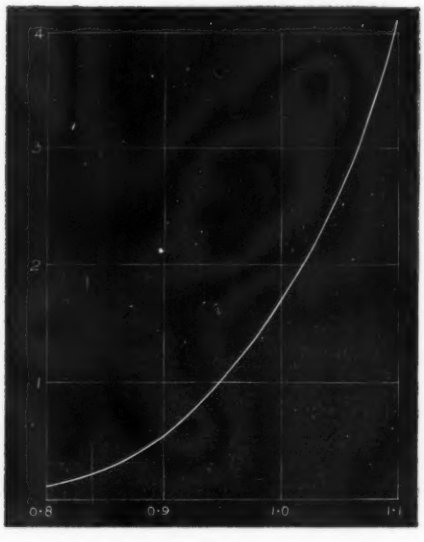
Alternate currents of high frequency would tend to flow on the surface of the conductors between the core and the expanded wall or the earth and the contracted wall.

In all these applications it must be noted that energy is stored up only in the tube walls.

If the tube walls are very thick, and contain other conductors in the neighbourhood of the original conductor, these would be affected both by participating in the flow of liquid

outside the tube if their ends were to earth, and also by the temporary pressure exerted on their walls, the yielding to which would cause liquid to be forced out or drawn in at their ends. Alterations of pressure set up in the earth anywhere along the tube will cause in a similar way a flow of liquid to or from such point, which will enter or leave the two ends in quantities depending on the resistance between such points and the respective ends, so that such earth disturbances will in general be quite different at the two ends of the tube. All these effects are deduced from statical pressures; there will be very different effects due to curl or vortex motion of the fluid generated by the impulse of the front of the tube wall, as it expands in a wave-like form under the advancing pressure along the tube; but this is outside the title of this communication.

I append a diagram giving a very small portion of the arrival curve referred to above, from an examination of which it is easily seen that, if signalling is effected by using only a small portion of the total possible current, increase of



E.M.F. will cause very little increase in speed. Suppose, for example, as would be the case in working an Atlantic cable, that with a certain E.M.F. only about ·0002 of total possible current is employed, then doubling the E.M.F. would increase the speed by only 7 per cent.; on the other hand, reducing the resistance of the battery is of great importance, as a greater rush of current into the cable at the first moment is thereby secured; it is on this account that the use of dry cells with their low internal resistance and great staying power, or of accumulators, should be adopted for all cables that are working at their highest possible speeds.

The ordinates give the values of the current, the unit being $\frac{1}{10000}$th of the maximum.

The abscissæ the time, the unit being 0·2332 K R, in seconds, where K R, is multiple of the total resistance of the cable into its total capacity expressed in megohm × microfarads.

F J.

LIMITS AND POSSIBILITIES OF THE GAS ENGINE.

The number of gas engines now in use is estimated by Geo. Richmond, in the *Engineering Magazine*, at 50,000; but this success is not, he thinks, due to its superior efficiency as a heat engine, when compared with steam. Convenience has been, he thinks, the ruling factor, and so far as engines of small power are concerned, we think with him, for a gas engine is not by any means a particularly cheap engine to run in itself, under the very usual conditions of illuminating gas as a source of fuel. It is the elimination of the boiler, and the saving of the attendant, of the ash and dirt, and so on, that have contributed to the wide sale of the small gas engine. But the economy of the gas engine, as a user of heat, is calling attention to its availableness for large powers, if cheap gas can be had. As a thermo-dynamic machine, the best steam engine has an efficiency of less than 20 per cent., and even a small gas engine will give this result. The ultimate limit of steam engine economy is about 1 lb. of coal per horse-power-hour; already gas engines yield 1 horse-power for $\frac{3}{4}$ths of a pound of fuel converted to "producer" gas, and though the difference is not great, it shows that the gas engine has arrived at the position of recognition, and that it will, in many cases, be chosen in preference to steam-power. Obviously the economy of the gas engine is due to the simplification of the conversion of fuel into rotative energy. The fuel is burned in the cylinder of the engine, instead of in a separate furnace, and there is no intermediate steam, while the chimney also opens direct from the working cylinder. Seeing that a chimney in a steam plant discharges from 20 to 40 per cent. of the heat of combustion, the exhaust pressure of the gas engine can be comparatively high, and yet bear only a relatively small ratio to the initial pressure, without introducing an abnormal waste. At present the steam engine, as a heat engine, is designed, or at least intended to be designed, on very much better lines than a gas engine. Designers profess to envelop the cylinders of steam engines with hot jackets. True these are as often cold jackets as not; nevertheless the designers mean well. But the designer of a gas engine does not mean well, except as a mechanic, when he surrounds his cylinder with a cold water jacket. The practice is quite indefensible on thermal grounds. Could the jacket be abolished, the fuel consumption of a gas engine might be reduced to half, or two-thirds what it is to-day, and the steam engine would be throughly beaten. The fact is, we cannot see further economy for steam except by possible ability to use still higher pressure and superheat. We can see much further economy in gas engine practice, if we can only drop deliberately planned methods for preventing it. Suppose that Watt had used a water jacket round the steam cylinder, and someone suddenly discovered how to do without it, and evolved the hot cylinder steam engine, what a discovery this would be; yet this is the discovery awaiting the successful gas engineer.

Mr. Richmond entirely overlooks the cold jacket. He states, however, that any further improvement in the efficiency of gas engines can only be secured by some radical departure from the so-called Otto cycle now universally adopted. Theoretically, as pointed out by Dugald Clerk, the efficiency of a gas engine can be indefinitely increased by increasing the compression; but the increase of stresses must be very great, and this would demand heavier and more bulky engines, and the theoretical increase in the efficiency would be soon more than counterbalanced. The high pressure of exhaust is noticed by every observer of the gas engine, and nearly all makers have tried to reduce this by using it. To do so implies a large increase of cylinder capacity, and so far failure has resulted. Why is this? Consider for a moment the thermal capacity of the exhaust of a steam and of a gas engine. A cubic foot of steam at 45 lbs. pressure contains 130 thermal units. A cubic foot of air at the same pressure contains only 13 units, though its temperature is 740° under the usual conditions of the gas engine. Of course, the exhaust of a gas engine is not all air, but it is largely air or other gases, not steam, and it is obvious that the losses due to compounding the gas engine would be fatal, and our author concludes that the gas engine is very near its ultimate limit of efficiency, the chief prospect being in the direction of greater compression.

As regards the question of motors for road carriages, it is pointed out that each horse-power implies 43 thermal units per minute, and this implies another hundred units passing to the water jackets. This heat has to be dissipated, and it can only be dealt with satisfactorily by water, which must be boiled away and replenished.

A gas propelled vehicle must therefore carry water, and have means to renew it when evaporated. The mean cylinder temperature must be kept down to a safe point. This can be done apart, perhaps, from water aid, by using a weak mixture with delayed combustion, which is equivalent to late admission of throttled steam in a steam engine, or the final temperature can be kept down by increasing the expansion. Both of these methods mean less efficient working. Mr. Richmond says no reasonable air cooling device will get rid of the heat of a 3 or 4 horse motor working efficiently, and

so water is essential. In an appendix he illustrates diagrammatically a comparison of the steam and gas engine with Carnot's ideal cycle, showing, also, the effect of the water jacket, and he apparently proposes the cycle of Herr Diesel, as set forth in his book on a rational heat motor. Diesel proposed what he termed a fifth cycle of combustion after investigating four other cycles. His fifth cycle is based on the following hypothesis :—

"*If a given weight of air per unit of combustible be carefully chosen, not only will the whole heat imparted be utilised, but it will be imparted to the gases at a constant maximum temperature, and, therefore, according to the laws of thermodynamics, the maximum possible work will be obtained.*"

Diesel's proposition is thus to select a maximum practicable cylinder temperature safe without need of water jacket. To this temperature he would compress the charge which would ignite spontaneously, and as the charge cooled by expansion, he would add more combustible to maintain an expansion line which should be isothermal. In working out his theory for a practical case, Diesel assumed a maximum temperature of 800° Centigrade, but he did not consider this to be the highest possible limit, and he fixed compression at 200 to 300 atmospheres, and he claimed an efficiency of 73 per cent., or ten-fold that of the steam engine. But, allowing for imperfections, he let down this claim to about five or six times the efficiency of steam. He obtains an isothermal compression by injection of water. To avoid this, he proposed a modification of the fifth cycle, and suggested adiabatic compression to only 90 atmospheres without water, and after that, the isothermal expansion which he would secure by dribbling in fine dust coal as the piston travelled on its expansion stroke. In this way alone can the gas engine be improved, and very great improvement can be made even with compression to 40 or 50 atmospheres, and no cylinder cooling will be needed. No doubt Diesel went to extremes, but he showed on what lines increased efficiencies might be possible, and it is well to remember that gas engine efficiency is not a function of high temperature, but of high compression. Mr. Richmond emphasises this point, though he refers to Diesel's system as an extreme application of the theory of compression. We do not seem to have heard anything of the result of Herr Diesel's motor which was being constructed to test his principles.

CHELTENHAM FATALITY.

Major Cardew's Report on a Fatal Accident in connection with the Electric Light Supply of the Cheltenham Corporation.

Board of Trade (Harbour Department),
8, Richmond Terrace, Whitehall, London, S.W.,
January 20th, 1896.

Sir,—I have the honour to report, for the information of the Board of Trade, that in compliance with the instructions contained in your Minute of the 3rd inst., I have held an inquiry into the cause of the death of John Pugh, mechanic, on the 16th ult., while employed by the Corporation of Cheltenham in carrying out some alterations in one of the transforming chambers used by this Corporation for the purposes of their electric light supply.

The inquiry was held on the 15th inst.

The following witnesses were examined, viz.:—

Leicester Richards Lee, engineer.
Richard Edwards, jointer.
M. H. Kilgour, borough electrical engineer.
Richard Cresswell, D.Ph., surgeon.

They severally confirmed the evidence previously given by them at the coroner's inquest.

I carefully examined the chamber in which the accident took place, and I also visited the generating station.

Account of Accident.

The circumstances of the case are, I find, as follows:—

The Corporation of Cheltenham supply electric energy by means of a high pressure alternating current, at a constant pressure of 2,000 volts, which is reduced by means of transformers placed partly in transforming stations below the level of the street, and partly on consumers' premises, to a pressure of 100 volts, for purposes of supply to consumers.

The transforming stations are larger than those usually constructed for the purpose, and are in all respects suitable in construction. The arrangements within them consist, in addition to the transformers, of high pressure and low pressure switchboards for regulating purposes.

The particular station in question contains an extra number of high pressure switches, as from it is controlled the supply to another transforming station.

The work upon which the party were engaged at the time of the accident was the erection of a low pressure switchboard on the north wall, in a position closely adjacent to one of the high pressure switchboards. The unfortunate man was at the time boring a hole in a wooden batten with a large gimlet at a distance of only about 4 inches from the high pressure switchboard, on which were fixed several switches with exposed metal surfaces, charged to the full pressure of 2,000 volts.

The conditions, in fact, were such that although it was possible to do the work without making contact with the charged metal, it required continual care and attention to avoid the fatal consequence of an unguarded movement.

The danger was, I consider, almost equal to that of sending a man into a magazine full of loose powder with a lighted candle in his hand.

From the evidence of the foreman under whom Pugh was employed, it appears that the latter was decidedly careless by nature, and that before the accident happened he had been cautioned several times.

An India-rubber mat had been provided as a protection to be used when working at the high pressure switchboards, but had been moved away, probably by the men at work, as not being required since they were not manipulating the electric circuits. India-rubber gloves were also provided, but the use of these would certainly have been inconvenient.

The accident appears to have been caused by Pugh in a moment of forgetfulness raising his left arm until it came, as it naturally would, into contact with the charged metal in two places, causing wounds as described by Dr. Cresswell, the current entering his body by this arm, and leaving it partly by his feet and partly by his right hand, assuming that he was grasping the gimlet at the time.

The abrasions on the face were probably caused in his fall, either by a simple blow or a subsequent contact.

Death appears to have been practically instantaneous.

Opinion and Recommendations.

In my opinion this accident is chiefly to be attributed to an error in judgment on the part of those responsible in allowing such work to be carried on in close proximity to highly charged metal.

It is too much to expect that any man, and especially an imperfectly educated man, should exercise such continual care over all the movements of his body as was necessary in this case when he is engaged upon work distracting his attention from the danger, and when the danger itself is not of a kind that appeals to the ordinary senses.

I understand that had the electric pressure been switched off from the sub-station to enable the work to be done with safety, the supply to a few customers would have been interfered with to some extent. I ascertained, however, that the undertakers regularly stop supply altogether on Wednesdays for two hours in the middle of the day, and the work could have been carried out with absolute safety during this interval.

The fact appears to be that the possibility of danger was unfortunately overlooked.

Under ordinary conditions, no work other than attention to the electrical circuits should be carried on in any transforming station when any apparatus contained therein is charged to a high pressure.

In the second place I consider that the switching arrangements on the high pressure switchboards in use in this and other transforming stations, are needlessly dangerous, in that large surfaces of charged metal are exposed, which could easily be covered by solid insulating material, so as to render an accidental contact with them impossible.

I was pleased to find that on the main switchboard at the generating station well designed arrangements have been made for the guarding of all charged metal. Some similar arrangements should be carried out on the switchboards in the transforming stations.

The necessity for some alteration in this respect is now fully recognised by the borough electrical engineer, who had prepared for my inspection a model of an insulating cap to partially cover the charged metal. It appeared to me, however, that the protection could be made more complete, and my suggestions are now, I understand, under consideration.

Thirdly, I would suggest that in all the transforming stations a thoroughly insulated floor should be provided, as can easily be done at a small expense. The India-rubber mats at present used are probably effective, but they are easily displaced.

They should be retained for use on the insulated floor as an additional precaution.

There should also be, in every case where it can be arranged, a stout wooden rail or other division to separate off the portion of the chamber in which high pressure apparatus is fixed.

Finally, the Board of Trade should, I consider, request the immediate attention of the Corporation of Cheltenham to the remarks and suggestions contained in this report.

Those who undertake the supply of electrical energy at a pressure which involves the danger of sudden death from a cause so unnatural and so remote from human experience as the mere contact with a piece of metal, and who in their operations necessarily employ men of imperfect education, untrained to grasp abstract ideas, have a heavy moral responsibility for the safety of their employés.

I feel confident that the Corporation of Cheltenham and their electrical engineer fully realise their responsibilities in this matter, and that they will spare no expense or exertion to prevent for the future any accident to their employés.

I have, &c.,
P. Cardew.

The Assistant Secretary,
Harbour Department, Board of Trade.

DIMINUTION OF RISKS WITH ELECTRIC LIGHTING.

The following suggestions are, according to the *Scientific American*, offered by the American National Board of Fire Underwriters to people who are about to employ electric lighting:—

1. Have your wiring done by responsible parties, and make contract subject to underwriters' rules. Cheap work and dangerous work usually go hand in hand.
2. Switch bases and cut-out blocks should be non-combustible (porcelain or glass).
3. Incandescent lamps get hot; therefore all inflammable material should be kept away from them. Many fires have been caused by inflammable goods being placed in contact with incandescent lamp globes and sockets.
4. The use of flexible cord should be restricted to straight pendant drops and should not be used in show windows.
5. Wires should be supported on glass or porcelain, and never on wooded cleats; or else run in approved conduits.
6. Wires should not approach each other nearer than 8 inches in arc and 2½ inches in incandescent lighting.
7. Wires should not come into contact with metal pipes.
8. Metal staples to fasten wires should not be used.
9. Wires should not come into contact with other substances than their designed insulating supports.
10. All joints and splices should be thoroughly soldered and carefully wrapped with tape.
11. Wires should always be protected with tubes of glass or porcelain where passing through walls, partitions, timbers, &c. Soft rubber tube is especially dangerous.
12. All combination fixtures, such as gas fixtures and electric lamps attached, should have approved insulating joints. The use of soft rubber or any material in such joints that will shrink or crack by variation of temperature is dangerous.
13. Electric gas lighting and electric lights on the same fixture always increase the hazard of fire, and should accordingly be avoided.
14. An electric arc light gives off sparks and embers. All arc lamps in vicinity of inflammable material should have wire nets surrounding the globe, and such spark arresters reaching from globe to body of lamp as will prevent the escape of sparks, melted copper and particles of carbon.
15. Arc light wires should never be concealed.
16. Current from street railway wires should never be used for lighting or power in any building, as it is extremely dangerous.
17. When possible, the current should be shut off by a switch where the wires enter the building when the lights or power are not in use.
18. Remember that "resistance boxes," "regulators," "controllers," "rheostats," "reducers," and all such things are sources of heat and should be treated like stoves. Any resistance introduced in an electric circuit transforms electric energy into heat. Electric heaters are constructed on this principle. Do not use wooden cases for these stoves, nor mount them on woodwork.

ON THE GENERATION OF LONGITUDINAL WAVES IN ETHER.*

By Lord KELVIN, F.R.S.

In a short note published in last week's *Nature*, of which a copy is appended, I suggested an arrangement of four insulated and electrified spherical conductors with their centres in one line, giving rise to ethereal waves in the surrounding atmosphere, of which the disturbance in the line of centres is essentially longitudinal. But at any finite distance from this line there must also be laminar or distortional waves of the kind expressed in Maxwell's equations. The object of my present communication is to show an arrangement by which a large space of air is traversed by pressural disturbance, or by waves essentially longitudinal, or by condensational-rarefactional vibrations; with but a very small proportion, practically evanescent, of laminar waves.

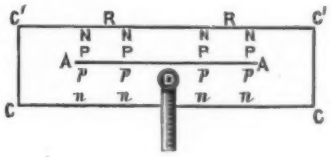
Let A, A be a plane circular metal plate insulated within a metal case C C C′ C′, as indicated in the drawing. Let D be a discharger which can be pushed in so as to make contact with A.

Let A be charged to begin with, positively, for instance, as indicated by the letters P P P P; N N N N, showing negative electricity induced by it. Let now the discharger be pushed in till a spark passes. The result, as regards the space between A A and the roof, B B, over it, will be either an instantaneous transmission of commencement of annulment of electrostatic force, or a set of electric waves of almost purely longitudinal displacement, according as ether is incompressible or compressible.

Hence, if the theory of longitudinal waves, suggested by Röntgen as the explanation of his discovery (for the consideration of which he has given strong reasons), be true, it would seem probable that a sensitive photographic plate in the space between A A and B B should be acted on, as sensitive plates are, by Röntgen rays. Either a Wimshurst electrical machine or an induction coil, adapted to keep incessantly charging A A with great rapidity so as to cause an exceedingly rapid succession of sparks between D and A, might give a practical result. In trying for it, the light of the sparks at D must be carefully screened to prevent general illumination of the interior of the case and ordinary photographic action on the sensitive plate.

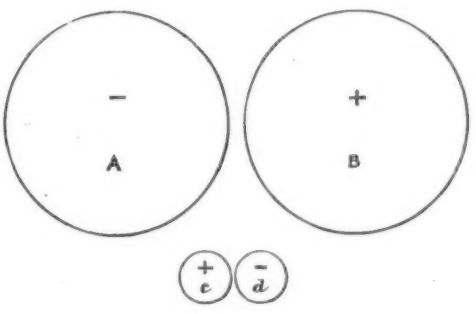
The arrangement may be varied by making the roof of sheet aluminium perhaps about a millimetre thick, and placing the sensitive photographic plate or phosphorescent substance on the outside of this roof, or in any convenient position above it. When a photographic plate is used there must, of course, be an outer cover of metal or of wood to shut out all ordinary light from above. This arrangement will allow the spark gap at D to be made wider and wider, until, in preference, the sparks pass between A A and the aluminium roof above it. The transparency of the aluminium for Röntgen light will allow the photographic plate to be marked, if enough of this kind of light is produced in the space between the roof and A A, whether with or without sparks.

The new photography has hitherto, so far as generally known, been performed only by light obtained from electric action in vacuum; but that vacuum is not essential for the generation of the Röntgen light seems demonstrated by an experiment by Lord Blythswood, which he described at a meeting of the Glasgow Philosophical Society last



Wednesday (February 5th). As a result he exhibited a glass photographic dry plate with splendidly clear marking which had been produced on it when placed inside its dark slide, wrapped round many times in black velvet cloth, and held in front of the space between the main electrodes of his powerful Wimshurst electrical machine, but not in the direct line of the discharge. He also exhibited photographic results obtained from the same arrangement with only the difference that the dark slide wrapped in black velvet was held in the direct line of the discharge. In this case, the photographic result was due, perhaps, wholly and certainly in part to electric sparks or brushes inside the enclosing box, which was as usual made of mahogany with metal hinges and interior metal mountings. I have suggested to him to repeat his experiments with a thoroughly well closed aluminium box, instead of the ordinary photographic dark slide which he used, and without any black cloth wrapped round outside. The complete metallic enclosure will be a perfect guarantee against any sparks or brushes inside.

If the arrangement which I now suggest, with no sparks or brushes between A A and the roof, gives a satisfactory photographic result, or if it shows a visible glow on phosphorescent material placed anywhere in the space between A A and the roof above it, or above the aluminium roof, it would prove the truth of Röntgen's hypothesis. But failure to obtain any such results would not disprove this hypothesis. The electric action, even with the place of the spark so close to the field of the action sought for as it is at D in the suggested arrangement, may not be sudden enough or violent enough to produce enough of longitudinal waves, or of condensational-rarefactional vibrations, to act sensibly on a photographic plate, or to produce a visible glow on a phosphorescent substance.



(Extract from *Nature*, referred to above.)

"Velocity of Propogation of Electrostatic Force.

"Dr. Bottomley's note published in *Nature*, of January 23rd, quotes an extract from my Baltimore Lectures of October, 1884, in which this subject is spoken of, with an illustration consisting of two metal spheres at a great distance asunder, having periodically varying opposite electrifications maintained in them by a wire connecting them through an alternate current dynamo.

"For an illustration absolutely freed from connecting wire and all complications, consider four metal spheres, A, B, *c*, *d*, with their centres all in one straight line; their relative magnitudes and positions being such as shown in the accompanying diagram. Let each of the four be initially electrified, A and *c* positively, B and *d* negatively. Let the charges on *c* and *d* be so strong that a spark is only just

* Read before the Royal Society, February 13th, 1896. Received February 10th, 1896.

prevented from passing between them by the influence of B and A. Let A be gradually brought nearer to B till a spark passes between them. Will the consequent spark between *c* and *d* take place at the same instant or a little later? It is not easy to see how this question could be answered experimentally; but remembering the wonderful ingenuity shown by Hertz in finding how to answer questions related to it, we need not, perhaps, despair to see *it* also answered by experiment.

"The elastic solid theory restricted to the supposition of incompressibility (which is expressed by Maxwell's formulas) makes the difference of times between the two sparks infinitely small. The unrestricted elastic solid theory gives for the difference of times the amount calculated according to the velocity of the condensational-rarefactional wave.

"But I feel that it is an abuse of words to speak of the 'elastic solid theory of electricity and magnetism' when no one hitherto has shown how to find in an elastic solid anything analogous to the attraction between rubbed sealing-wax and a little fragment of paper; or between a loadstone or steel magnet and a piece of iron; or between two wires conveying electric currents. Elastic solid, however, we must have, or a definite mechanical analogue of it, for the undulatory theory of light and of magnetic waves and of electric waves. And consideration of the definite knowledge we have of the properties of a real elastic solid, which we have learned from observation and experiment, aided by mathematics, is exceedingly valuable in suggesting and guiding ideas towards a general theory which shall include light (old and new), old and new knowledge of electricity, and the whole of electro-magnetism. "KELVIN."

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents*, 31, *High Holborn, London, W.C., to whom all inquiries should be addressed. Copies of any of the specifications may be obtained of* Messrs. W. P. THOMPSON & Co., *price, post free*, 8½*d. (in stamps.)*]

NEW PATENTS.—1896.

2,419. "Improvements in electric pendulum indicators." F. JONES. Dated February 3rd.

2,427. "An improvement in apparatus for measuring electrical resistances." E. H. GRIFFITHS. Dated February 3rd.

2,435. "An improved dialytic process of decomposing stable salts and thereby creating electrical energy." C. BUDERUS and J. MENZ. Dated February 3rd.

2,437. "Improved means of applying the heat of the electric arc for welding, soldering, and other purposes." A. HIRSCH. Dated February 3rd.

2,447. "Improvements relating to telephones." MUIRHEAD & Co., and F. L. MUIRHEAD. Dated February 3rd.

2,459. "Improved apparatus for electric welding, soldering, and other purposes for which intense local heat is required." A. HIRSCH. Dated February 3rd.

2,501. "An improved system for conveying and furnishing electricity to railway cars and devices used in connection therewith." A. S. KROTZ, W. P. ALLEN, and O. S. KELLY. Dated February 4th.

2,523. An electric railway system." A. CASAZZA. Dated February 4th.

2,545. "Improvements in automatic current regulators." H. H. LAKE. (S. C. C. Currie, United States.) Dated February 4th.

2,591. "Improvements in telephonic apparatus." E. W. SMITH, and the NEW PHONOPORE TELEPHONE COMPANY, LIMITED. Dated February 4th.

2,594. "An improved electrolytic process for extraction of caustic alkali and of hydrochloric acid from a chloride." A. J. BOULT. (F. Villani, Italy). Dated February 4th.

2,610. "Improvements in the construction of dynamo-electric machines and electro-motors." E. S. G. REES. Dated February 5th.

2,623. "Electric targets and the like." W. W. MCLAUCHLAN. Dated February 5th.

2,665. "A new non-inductive adjustable carbon resistance." S. P. BLACKMORE. Dated February 5th.

2,666. "An improved fluid for use in galvanic batteries and the like." J. E. PRESTON. Dated February 5th.

2,674. "Improvements relating to armatures for dynamo-electric machinery." P. R. JACKSON & Co., LIMITED and J. S. LEWIS. Dated February 5th.

2,683. "Improvements in electricity motors." G. HOOKHAM. Dated February 5th.

2,707. "Improvements in incandescent electric lamps, holders and the like." A. J. HOWARD. Dated February 6th.

2,717. "Improvement in controlling switches for dynamo-electric machines." F. H. ROYCE and E. A. CLAREMONT. Dated February 6th.

2,745. "Improvements in apparatus for blowing organs by electric motors." B. M. DRAKE and J. M. GORHAM. Dated February 6th.

2,767. "Improvements in telephonic systems and in switching apparatus for use therein." A. R. BENNETT and G. J. SOMERVILLE. Dated February 6th.

2,772. "Method and apparatus for effecting the connection in parallel of alternate current and polyphase dynamos and motors." SIEMENS BROS. & Co., LIMITED. (Siemens & Halske, Germany.) Dated February 6th.

2,773. "Improvements in and connected with portable electric lamps." C. N. GAUZENTES. Dated February 6th.

2,845. "Improvements in detonator signalling apparatus for railways." W. J. BONSER. Dated February 7th.

2 573. "Improvements in culverts for electrical conductors, and means of supporting the conductors therein." H. L. DOULTON and C. E. MORRIS. Dated February 8th.

2,875. "Improvements in or connected with electric incandescent lamps." H. H. HALL and W. D. CHEYNE. Dated February 8th.

2 894. "An improved electric alarm clock." A. H. WEBB. Dated February 8th.

2,909. "Improvements in secondary or storage batteries." L. FALERO and H. LUMLEY. Dated February 8th.

2,915. "An improved electric gas igniting and extinguishing apparatus." A. CZARNIKOW. Dated February 8th.

2,923. "Improvements in alternate current dynamos." W. C. JOHNSON, L. J. STEELE, and J. W. EWART. Dated February 8th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1895.

13,436. "Improvements in electric light suspension fittings." L. B. MILLER. Dated July 12th. A counterweight fitting for suspending lamps by a single cord. A hollow case made up of two half shells screwed together and containing a differential pulley of insulating material and consisting of two drums of unequal diameter. The shells are bushed at the top and bottom. 6 claims.

17,830. "Improvements in and relating to mechanism for electrically indicating the extinction of lamps and for analagous purposes." H. H. LAKE. (Horace See, U.S.A.) Dated September 24th. Ship's lights are constructed with two incandescent lamps on either side only one of which is normally lighted. On the extinction of either of the lamps a magnet becomes de-energised, releasing a spring controlled armature carrying a signal which swings opposite an opening. At the same moment the armature comes in contact with a fixed stock and closes a secondary circuit which swings a bell and lights the remaining idle lamp. 3 claims.

18,038. "Improvements in and appertaining to electrodes." H. LEITNER and E. REICHER. Dated September 26th. The outside case of the cell is formed of celluloid or other resisting material. Round the sides of this fits a carbon tube lined with another of peroxide of lead. The core is formed of a vulcanite staff upon supporting a leaden tube upon which pure zinc is precipitated. 1 claim.

19,862. "Improvements in dynamo-electric machines." J. DEVONSHIRE. (E. Thomson, U.S.A.) Dated October 22nd. Relates to machines of the multipolar type directly connected for a number of arc light circuits. The armature is stationary and is provided with a number of independent sets of windings, gives a three-phase current, and is connected to an independent circuit through a suitable commutator driven synchronously. If, however, the machine is not required for feeding arc lamps, the commutators may be dispensed with and transformers for suitable description used. The several sections of the armature, each supporting one set of windings, are arranged to be removable for repair without disturbing the remaining portion of the machine. 10 claims.

19,947. "Improvements in electric contact devices or couplings." C. MORADELLI. Dated October 23rd. Two enlarged cylinders pointed at the ends are pivoted eccentrically at the ends of the conductors to be joined. When the ends of the conductors are run together, the cylinders fall by gravity and form a contact. 3 claims.

20,017. "An improvement in the caps of incandescent electric lamps." THE EDISON & SWAN UNITED ELECTRIC LIGHT Co., LIMITED, and A. WOODLEY. Dated October 24th. Obviates the present plaster of Paris bedding, by forming the top of the glass bulb with a rounded dovetail which is grasped by a plate and drawn up by screw working in the outside socket, until the bulb is drawn up hard against the socket. 1 claim.

20,392. "Improvements in and relating to arc lamps." M. WHELESS. Dated October 29th. Relates to constructional details, the specification not permitting abridgment. 7 claims.

21,556. "Improvements in microphones or telephone transmitters." W. P. THOMPSON. (The firm of Hammacher & Paetzold.) Dated November 13th. Obviates the short circuiting in present carbon grain transmitters caused by loose powder dust. The diaphragm lies on an annular metal support screwed to the mouth-piece of the microphone and held fast by clamps. Into a brass ring insulated from the annular support a back disc is screwed, provided with recesses for the carbon grain. A spring contact conveys the current from the back disc to the induction coils. The powder falling off the carbon grains when the device is placed in a vertical position drops between the back plate and the brass ring and can easily be removed. 1 claim.

21,623. "Improvements in the fittings of incandescence electric lamps." W. J. FOX. Dated November 14th. The connecting band of ordinary incandescence lamps enclosing the plaster of Paris is formed with an indentation or annular groove, so that the strain of the composition tends to consolidate the whole upon the shoulder, and thereby save the contact, which is so often broken when the full force of the current comes upon the composition. 1 claim.